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THE JUNGFRAU RAILWAY.

THE construction of a railway so unique in all its aspects as to command very general attention will be commenced this summer in Switzerland. We refer to the proposed railway to the summit of the Jungfrau—the most dominating, although not quite the loftiest, peak in the whole chain of the Bernese Alps. Rising from the Lauterbrunnen Valley, on the north side of the range, in vast towering rocky walls, which often seem literally perpendicular, its bold outline is seen clearly against the dark blue sky of a bright summer's day, dazzling the eye by the spotless purity of its snowy mantle, and forming one of the most impressive spectacles which much favored Switzerland has to offer to the vast numbers of tourists who flock to her beautiful highlands every year. As far back as the year 1872, when the rack line up the Rigi was opened for traffic, a popular feeling made itself felt through the Swiss republic that the time had come when science should lend its aid toward rendering some of those points which were renowned for the beauty of the scenery, and for the mountain views, more accessible to the general public, without requiring an often impossible outlay, such as had been usual when delicate or elderly persons had ridden on mules up the mountains, or even allowed themselves to be carried up in litters. Many projects were formed, but the period of universal commercial depression which set in during 1874 prevented their being realized, and for more than ten years but little progress was made. It was only about the years 1886 and 1887 that activity in the building of mountain railways really manifested itself, but since that date—or, in other words, during the last ten years—great advances have been made. Switzerland can now boast of upward of twenty tourist lines, partly worked on the rack principle with steam locomotives, and partly with cables—a rack in this case generally being also adopted as a safety precaution, so that the brakes are as far as possible perfectly safe acting. A rack line, worked directly by steam power, has also for the last four years been open for traffic between Lauterbrunnen and Grindelwald, passing over the Wengern Alp and Little Scheidegg, skirting the Jungfrau range, and reaching an altitude of 6,770 feet above the sea level.

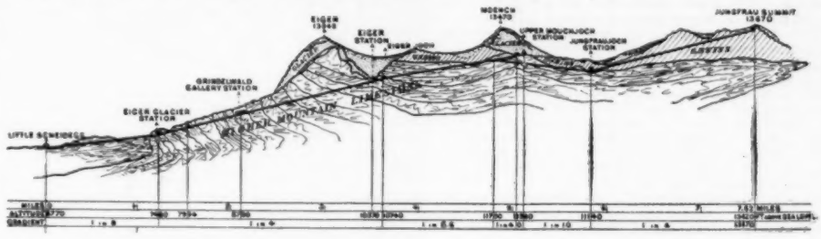


FIG. 1.—PROFILE AND GEOLOGICAL SECTION OF THE JUNGFRAU RAILWAY.

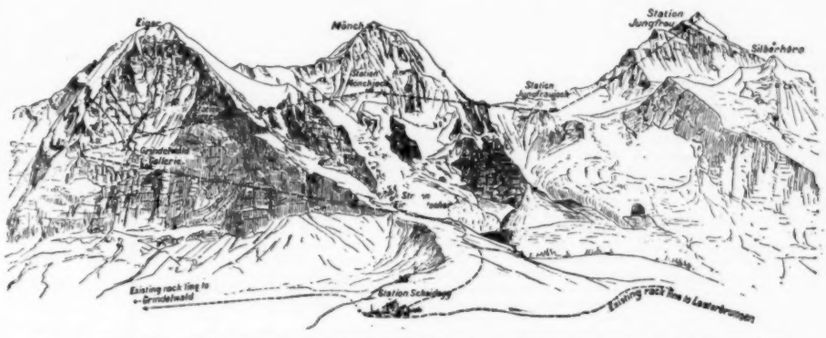


FIG. 2.—PERSPECTIVE VIEW OF THE MOUNTAIN RANGE, SHOWING THE COURSE OF THE JUNGFRAU RAILWAY.

The main tourist traffic being chiefly concentrated on the north side of the mountain chain, with Interlaken as its center point, it was natural that a Jungfrau railway should start from the Little Scheidegg. From here a vertical height of 6,900 feet must be surmounted, and it is evident that as the horizontal distance between the Scheidegg and the Jungfrau summit is only some 3½ miles, either very steep gradients must be adopted or the line must make a very considerable detour. But excessively steep gradients are certainly not to be re-

THE JUNGFRAU.

commended for many reasons, two of these being, first, they reduce the proportion of paying to total load of a train enormously, and, secondly, they limit the amount of traffic that can be passed over the line. Now the importance of the first of these points will be seen if we calculate the weight of train a given engine can draw on gradients of say 1 in 8, 1 in 5, 1 in 4, and 1 in 3. Assuming that a rack steam locomotive of the best construction is used, the tractive power it exerts may be said to be equal to 0·4 its own weight. Such engines are in general use in Switzerland on gradients of 1 in 5 and 1 in 4, and their weight is on the average about 16 tons. The tractive power is then about 6·4 tons, and the loads drawn as follows:

On 1 in 8	32	tons.
" 1 in 5	14·6	"
" 1 in 4	8·6	"
" 1 in 3	2·6	"

The second objection is simply a statement of the consequences resulting from the first. On gradients of 1 in 4 a speed of 5 miles per hour may be taken as the maximum, while on 1 in 2 it could hardly be greater than 2 to 2¼ miles per hour. Considering these points, it was decided to fix the limit at 1 in 4, and, as sufficient water power was at disposal in the valleys lower down the range, electricity was adopted as the motive power.

After many important studies of the formation of the range in both its geographical and geological aspects had been made, the alignment was finally decided upon, and in Figs. 1 and 2 the main features of the same are shown. Fig. 1 is a profile of the line and at the same time a geological section of the ground traversed, while Fig. 2 is a perspective view of the range as seen from the Little Scheidegg. Owing to the natural conditions prevailing it was plainly impossible to carry out the line in the open, so with the exception of about the first mile of track the whole railway will be built in tunnels, thus avoiding any possible danger from avalanches, landslips, etc., while the disturbing influences of weather on the building operations are at once removed. As will be seen, the line enters the mountain near the foot of the Eiger glacier, and thence, running parallel to the northern face of the Eiger for some distance, it describes a great curve, turning in a southwest direction, and, passing almost vertically under the summit of the Mouch, arrives at the Jungfrau "Joch" or Ridge. Thence it enters the interior of the Jungfrau itself, and ascending the great pyramid which forms the summit of the mountain, arrives at the terminus of the railway proper at a point about 250 feet below the surface. From here a lift will be built consisting of two concentric iron tubes, the inner one containing the cage for passengers, and the space between the inner and outer ones will be fitted with a spiral staircase. The upper end of this shaft emerges on to a small rocky plateau which will afford sufficient space for the necessary buildings for traffic purposes and the accommodation of passengers.

The total length of line thus projected is about 7½ miles, and the maximum gradient 1 in 4. Intermediate stations will be provided at the tunnel entrance or Eiger Glacier, Grindelwald Gallery, Eiger-Joch, Mouch, and Jungfrau-Joch. Of these, the first and fourth and the summit station will be situated in the open, in perfectly safe positions. The others will be built in the solid rock, and in all cases are not far from the surface, so that headings will be driven for ventilating purposes, and also for disposing of the tunneled material while building. After boring has been completed they will be utilized for station purposes, being fitted up with the necessary buildings, and affording the passengers most interesting views of different parts of the mountain range and also of the valleys. A single reverse gradient will be necessary between the Mouch and Jungfrau-Joch stations in order to avoid any risk of getting out of the rock and into the glaciers which cover the mountain here. Such an eventuality would mean very serious additional expense, and it was wisely deemed better to keep at such a distance from the surface as to insure no risk being run.

As will be seen by referring to Fig. 1, the geological conditions are unusually favorable. The greater part of the tunnel is situated in higher mountain limestone (Hochgebirgskalk, as the eminent Alpine geologist Studer named it), and the remainder is gneiss. The former is especially good for tunnel work, as it is compact as marble, while easily blasted, and it is confidently expected that no lining masonry will be needed. The mean temperature of the rock will probably range from 2° to 10° C., so that no trouble is incurred through water, and it seems probable that this low temperature will be found more convenient for work than those uncomfortably high ones which cause so much trouble in building long tunnels at lower altitudes than those of the Jungfrau Railway.

As we have already said, the motive power to be employed is electricity. The primary stations will be situated in the Lutschinen valley, at Burglauenen and Lauterbrunnen, where water rights to the extent of upward of 6,000 horse power have been acquired. The supply of water is practically unlimited, for the hotter the summer the more plentifully are the mountain torrents fed by the glaciers.

The dynamos will be of three-phase alternating type, and the current will, of course, be conducted to the Little Scheidegg in the usual way by overhead wires. Tunnels, stations and carriages will be lighted and heated, and the lift at the summit driven electrically. It is calculated that at the beginning about 1,400 horse power will be required, the maximum output of the plant being adapted for working three trains up the line and three trains down at the same time. It is thus evident that even if the expected traffic should be very largely exceeded, there is still an abundant reserve of power.

A train will consist of two carriages and a locomotor, the latter being driven by two dynamo motors. The seating accommodation of each carriage will be about thirty-five passengers. Only such light luggage as is necessary for the journey will be carried. The rack will be of an improved and simplified type, which it is expected will show a marked economy both in prime cost and maintenance. The gage is one meter, and the minimum radius of curvature 100 meters. The building estimates have apparently been prepared with care, and it is maintained by the promoters of the project that the outlay will not exceed $2,000,000, while the expected traffic is put down at a fairly modest figure, and one which may quite possibly be exceeded, for the Jungfrau Railway, being absolutely without a rival, must certainly prove an immense attraction to the tourist public.

The line will be built in sections, which will be open for traffic as soon as completed, and thus insure a considerable income during the time of building. The open section, Scheidegg-Eiger Glacier, was commenced last autumn, and it is hoped will be open for traffic by August of this year. As soon as the season permits, work will be started on the tunnel, and it will then probably be carried on, summer and winter, until completed.

The power station at Lauterbrunnen has already been begun, and, as the management is in energetic hands, there is no doubt that rapid progress will be made. It is expected that the whole line will be opened for traffic in about four years' time, so that the inauguration of the Jungfrau Railway will be an important event in the engineering records which will make the coming two-thousandth century notable.

The preliminary work was carried out with great thoroughness, the most eminent scientists of the country were invited to report on the various sides of the question, while the Swiss Federal government only granted the building rights under the strictest stipulations, designed to insure both financial and technical safety. Mr. Guyer-Zeller, of Zurich, chairman of the Swiss N. E. Railway, a gentleman of great business capacity and prominent in Swiss financial and railway circles, holds the concession for the railway, and it is due to his initiative that the company is being formed for building the line.

Both the scientific and railway world will watch with increasing interest the progress made by this unique undertaking, and when completed it will be another proof that energy and perseverance, aided by the latest developments of science, are able to-day to perform tasks which only a few years ago were deemed absolutely impossible, and the mere proposal of which would have been looked upon as a sure symptom of a disordered imagination.

For our profile and perspective views and the foregoing particulars, we are indebted to the Railway World.

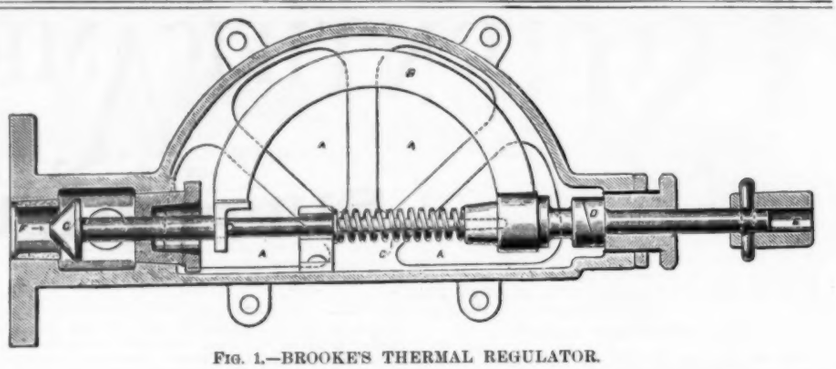
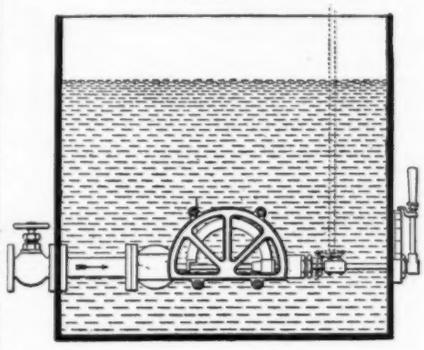


FIG. 1.—BROOKE'S THERMAL REGULATOR.

A THERMAL REGULATOR.

IN certain industries it is of importance that a volume of water or other liquid should be kept at an equable temperature for a considerable period. Various devices have been produced for so regulating the heat; one of the last that has come to our notice is that shown in Figs. 1, 2 and 3, which is made by Messrs. Holden & Brooke, of Salford. To those who are acquainted with the working of the Sirius steam trap, constructed by the same firm, the action of this thermal regulator will be clear, as the same principle is here embodied. In Fig. 1 B is the bent tube, which, as in the steam trap, tends to unfold when heated. At one extremity it is terminated by an inclined piece abutting against the adjustment piece, D, which is in connection through the coupling, E, with a handwheel or lever outside the tank, and at the other end it carries a bracket, the face of which presses against a shoulder on the spindle of the valve, G. The spring, C, of phosphor bronze or steel nickel plated, keeps one end of the tube firmly pressed against the adjustment piece, D, so that motion

FIG. 2.



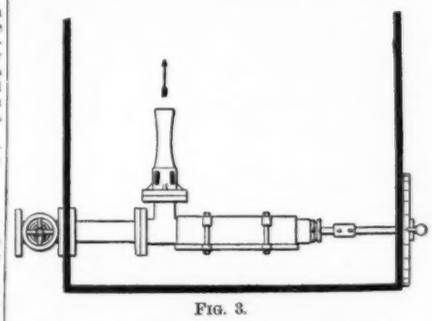


FIG. 3.

takes place at the other or free end, and tends to close or open the valve as the temperature falls or rises. Steam is admitted through F, and passes out by the passage seen behind the valve. The heated liquid is allowed free circulation round the whole apparatus through the sector shaped holes, A A. Figs. 2 and 3 show the thermal regulator situated in a vessel. We

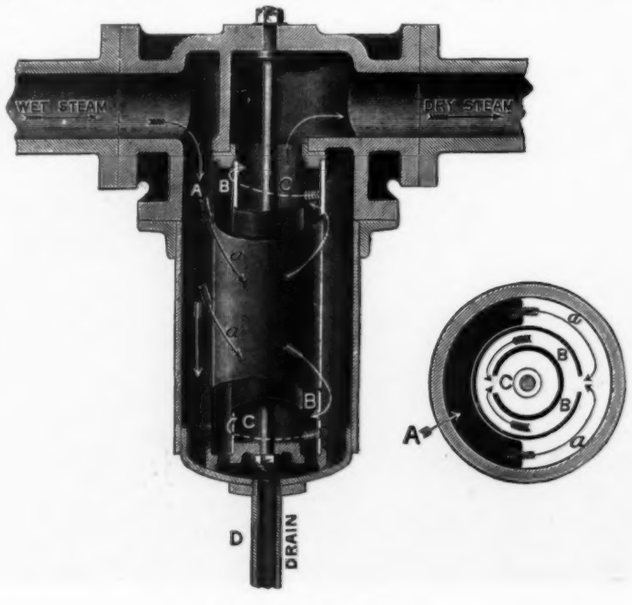
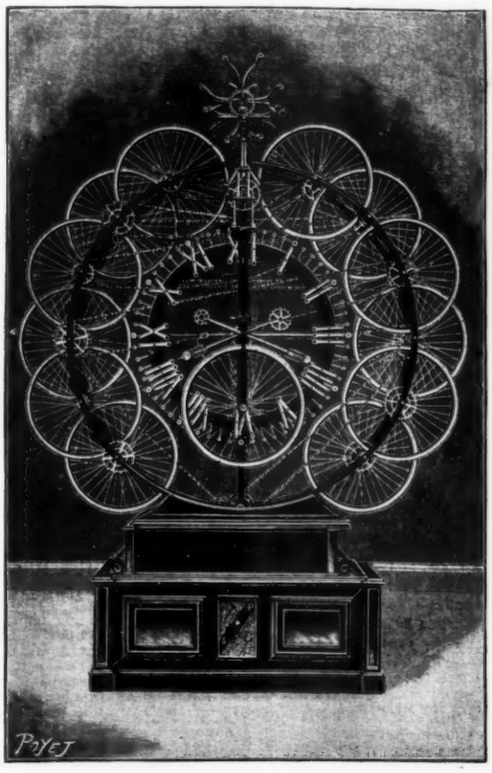


FIG. 4.—STEAM DRIER.

may take this opportunity of calling attention to a modification that Messrs. Holden & Brooke have introduced lately in their steam drier. It is with regard to the method of attaching the coils, and will we think be fully understood from Fig. 4. This appears to be a great improvement, as it renders the removal and replacement of the coils much easier than formerly. We are indebted to the London Engineer for the cuts and copy.



A BICYCLE CLOCK.

A BICYCLE CLOCK.

AMONG the curiosities that figured at the recent Cycle Exhibition at the Champs Elysees Palace, at Paris, it is well to mention particularly the curious bicycle clock shown at the stand of the Société Parisienne de Construction Vélocipédique. This immense clock, which was constructed entirely of parts of bicycles, attracted great attention from the throng of visitors present.

It is very likely the largest clock that has been constructed up to the present. All the movements are apparent, and all the parts are employed just as if they had been detached from bicycles. The idea, in fact, is original. It was a question of taking from a certain number of bicycles their principal parts—frames, handle bars, forks, cranks, wheels, etc., and of using them to form a colossal timepiece. So, in the first place, there was distinguished only a trophy erected to the "Little Queen;" and then, a second glance showed that the great circular frame held a genuine clock.

The clock struck the hours, the half hours and the quarters upon three tuned bells. All the wheels, provided with their pneumatic tires, and properly balanced, entered into the construction and constituted wheelwork of precision. The transmission was assured by chains with double rollers. The axles were mounted in ball bearings, and the whole ran with smoothness and remarkable regularity. Twelve intermediate parts transmitted motion to the hands. It resulted from this ingenious arrangement that an error in fastness or slowness in the pendulum was compensated for when the revolution was communicated to the hands. This is why the general running of the instrument was excellent and comparable to that of the best clocks. The movement, which, as before stated, was entirely visible, was actuated by a 440 pound weight. The pendulum consisted of a bicycle fork from the extremity of which, by way of a bob, was suspended a bicycle wheel. The hands were formed of crank arms, and their extremities of oil cans. Our figure, however, shows the arrangement with sufficient clearness to render a minuter description unnecessary.

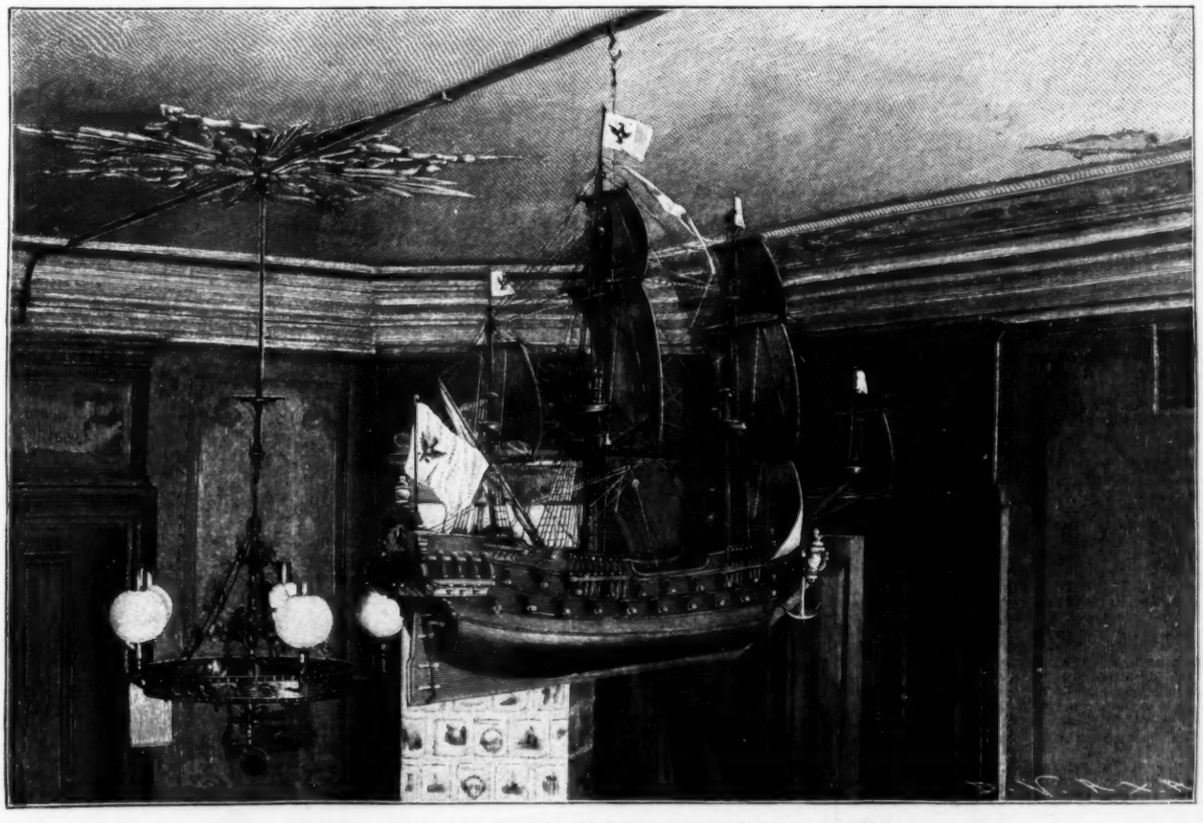
This clock, although simply a curiosity, is worthy of being made known, since it is the first model of the kind, and it is not very probable that any one will decide to manufacture these excellent timepieces, large or small, for bicyclist amateurs of clockwork.—La Nature.

A TRANS-JAPAN CANAL.

THE Japan Weekly Mail states that the long-talked-of idea of cutting a canal across the main island, to connect the Japan Sea with the Bay of Osaka, has been recently brought within the field of practicability. The originator of the project is Mr. Sakurada Sakesaku, who elaborated the design from the systems in vogue in France and Belgium. His main idea is to cut a canal from Tsuruga to Lake Biwa on the one hand and, on the other, to excavate a canal from Otsu to Rokujijomura via Yamashima. The scheme having obtained support in the Kei-Hin and Kei-Han districts, and in Echizen, Mr. Sakurada and his fellow-projectors have forwarded an application for a charter to the proper authorities, and have already established an office at Takiyamacho, Tokyo. The name of the canal will be the Central Canal of Japan. The capital is to be 2,750,000 yen, divided as below: First canal, between Teuruga and Otsu, distance of 13½ miles, approximately twelve yards wide, 1,500,000 yen; second canal, between Otsu and Rokujijo, situated on the banks of the River Uji, distance about nine miles, 12 yards wide, 1,250,000 yen. The projectors think that a dividend of over ten per cent. may be easily earned when the canal is in working order.

MODEL OF AN OLD VESSEL.

WE publish to-day an engraving showing one of the models of the old Brandenburg fleet which have been made by order of Emperor William II and presented by him to the "Seemannshaus" in Kiel, a home for officers and men of the German navy, established in 1895. The originals of these vessels were bought by the Great Elector for 109,340 thalers. The vessel shown in the accompanying cut, the Friedrich Wilhelm zu Pferd (Frederick William on Horseback), was provided with fifty guns, some of which were in a covered battery and some on the half covered upper deck. It had



MODEL OF AN OLD VESSEL IN THE SEEMANNSHAUS, IN KIEL.

three full rigged masts, from the tops of which, as well as from the stern, the Brandenburg flag waved. The stern was decorated with a representation of the Elector Frederick William on horseback.

We are indebted for our engraving to Ueber Land und Meer.

THE PUBLIC PIER OF PAUILLAC.

BORDEAUX is at present the third in rank among the great French commercial ports, coming as it does after Marseilles and Havre. These two latter cities are much more favorably situated from a marine point of view. It is difficult to understand how it was possible for a port of the size of that of Bordeaux to take rise at sixty miles from the sea. It required all the commercial activity that has developed in this city during the last four centuries to attain such a result.

Great sacrifices have been made in recent years in order to improve the situation of this great port. A floating dock, worthy of the importance of the port, by its size as well as by its equipment, has been constructed, and there was also a waterway projected, which, under the name of the Grattequina Canal, was to have permitted vessels of very heavy tonnage to profit by the advantages offered by the new docks. This project, however, fell through. Finally, there have been projected and constructed some new wharves which, in size and appointments, cede to no others. It has been well understood, besides, that it is nothing to prepare for the reception of large vessels, but that it is especially necessary to assure their access to all the works that have been constructed in their behalf.

In this respect, one has not been so fortunate. Despite the works of all kinds, the results obtained, appreciable as they are, have not produced others rapidly enough to prevail advantageously against the ever increasing tonnage of boats in general, and of those in particular that daily frequent the port of Bordeaux.

By river way, the distance between Bordeaux and the ocean is about sixty miles. In the first part of the estuary, between Pointe-de-Grave and Pauillac (30 miles), large vessels are capable of navigating at all times, but, unfortunately, the same is not the case in the second part, between Pauillac and Bordeaux. The river here becomes progressively narrower, and of the width of 3½ miles that it has in front of Pauillac, there remain but 1,640 ft. at Bordeaux. Moreover, it is strewed with islands that make the channels still narrower. If we add that dense fogs often prevail in winter, it will be seen to what an extent navigation becomes impossible, if not dangerous for all boats.

As for the packet boats of heavy tonnage that tie up at Bordeaux, they are obliged to land all their passengers and the greater part of their freight in the full river at Pauillac. When outward bound the operation is the reverse. They leave Bordeaux nearly empty, finish their loading at Pauillac and take their passengers aboard only at the last moment.

It will be seen how much loss of time the navigation companies experience by this fact. Now, it is to navigation especially that the celebrated maxim, "time is money," applies.

Bordeaux is, before all else, a very important terminus for travelers, and it is well for the prosperity of the city that the traffic be not diminished. Now, passengers complain, not without reason, of the length of the trip between Bordeaux and Pauillac, and vice versa, of the uncomfortableness of the small boats provided for carrying them, and of the real dangers that they may run.

A year ago, a boat of this kind, lost in a fog, tried for an entire afternoon to find a landing place, and at nightfall succeeded in anchoring near a hamlet where the hundred passengers were unable to find either food or lodging, and passed a night that they will remember for a long time to come.

Incoming vessels are in the same predicament, and a few years ago one of the largest English companies, the Pacific Steam Navigation Company, gave an example that has happily not been followed, by transferring its landing place to Palice.

The moment had come to be up and doing. It was necessary to begin a work of renovation capable of paralyzing without awaiting the nascent concurrence. Mr. Eugene Pereire saw that a few millions spent at Pauillac would assure the prosperity of Bordeaux and become a source of profit for the financial society that should undertake the construction of a stationary landing place at Pauillac. It was then that the Public Pier Society of Pauillac was formed.

Studies were at once made and rapidly pushed forward, and the work, intrusted to Messrs. Dayde & Pille, the skillful constructing engineers, was begun without delay. Unforeseen difficulties were met with at the very outset. The alternating and very violent currents that change direction four times every twenty-four hours many a time put the floating installations to the test. As the mud, which constituted the first soil to be traversed, had no consistency, it was impossible to fix the caissons, even when the depth reached was several yards. From the very first trials, the driving of the tubes presented difficulties such that the engineers were at the point of discarding the use of them. Messrs. Dayde & Pille then conceived the excellent idea of making use of an old bridge that had come into their possession. This they carried to the place piece by piece, set it up, added a central trussing to it, and made it bear upon the masonry piers that had already been constructed, and in this way obtained a stability for the tubes that no anchoring would have given them, and which was, nevertheless, indispensable for the proper execution of the work.

The work, which comprised very important accessory installations, was entirely completed at the end of 1895, and has been in use for the past year. Fig. 1 shows its position with respect to Pauillac; Fig. 2, the arrangements made for driving the tubes; and Fig. 3, the work terminated.

The landing, properly so called, rests upon twenty masonry piers founded upon rock by means of compressed air at a mean depth of 40 ft. beneath low water—the stratum of mud upon the rock being, consequently, about 12 ft. at 28 ft. of water below the same level. These piers are rectangular, and are 16 × 22 ft. at the base and 13 × 18·5 ft. at the summit. The space between them is filled in with 91 cast iron tubes set into the rock by means of compressed air. They have an external diameter of 4 ft. and a thickness of 10 in. Girders, 37 in number, connect the rows of piers and tubes transversely, or simply the three tubes in the intervals of the piers. These girders are 38½ in. in height and are provided with angle irons of 32 in. All the rows are cross braced transversely. The flooring consists of 16 longitudinal beams connected by diagonal stays and upon which rest oak planks placed lengthwise. The tracks are provided here and there with turntables. The pier is connected with terra firma by a curved foot bridge resting upon cast iron tubes of the same model as those already described. A strong masonry abutment receives the land end. The pier is capable of easily receiving seven boats at once, and is fully adequate for the traffic of the river, especially if it be considered that, thanks to the apparatus to be described further along, the loading and unloading are done with great rapidity and in a very short time. Fig. 4 shows us a boat in the process of loading. The machinery is designed to actuate the hydraulic cranes and the dynamos for producing electric light. Three Naeyer generators, each having a heating surface of 950 sq. ft., produce the steam. Three 80 horse power pumps force water under an 80 ton counterpoise that produces a constant pressure of 16 pounds to the square inch in the conduits that lead water to the cranes.

The dynamos are actuated by a Laval turbine that makes 1,600 revolutions per minute. The water necessary for the hydraulic apparatus is furnished by an

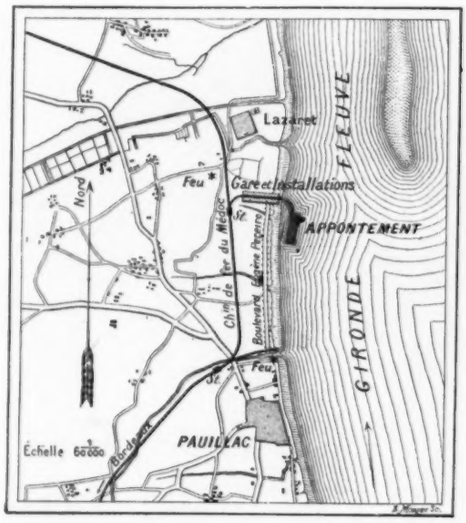


FIG. 1.—MAP SHOWING THE SITE OF THE PAUILLAC PIER.

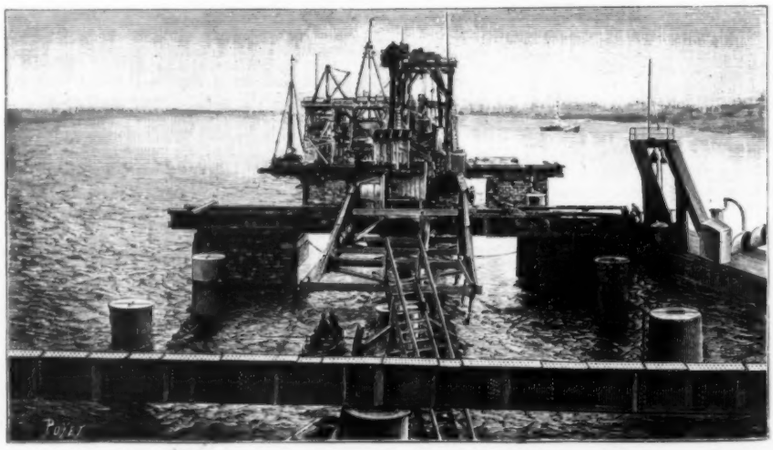


FIG. 2.—THE WORK OF DRIVING THE TUBES.

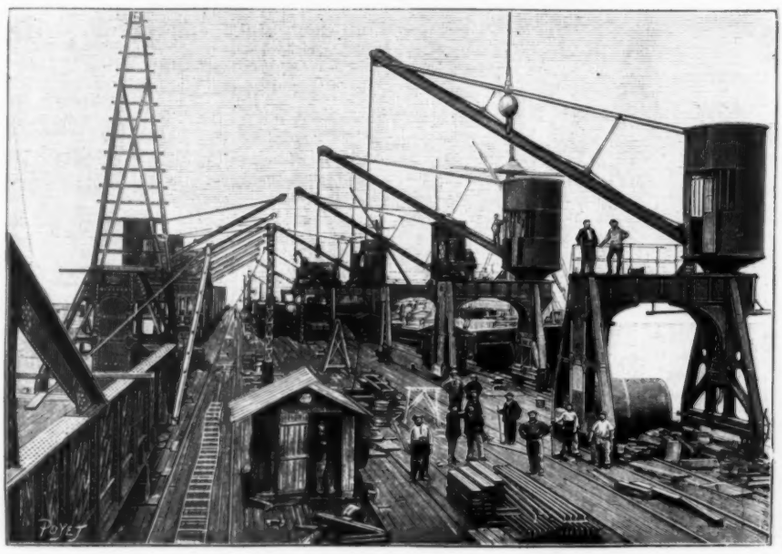


FIG. 3.—VIEW OF THE PRELIMINARY WORK TERMINATED.

artesian well driven to a depth of 1,368 ft. and discharging 8,700 gallons an hour. The water is filtered before reaching the pumps.

We must now make known the arrangements adopted for causing the counterpoise to rise. It is this counterpoise which, having descended to a certain level, opens the steam port of the pumps, which by this fact set themselves in motion automatically. The stoppage of the machine is produced in the same way when the counterpoise reaches the level above which it is not to ascend. But since in this latter case a real danger would occur if, for any cause whatever, a stoppage of the pumps did not take place, the counterpoise, at a few fractions of an inch above, meets a lever that controls a discharge valve whose volume of flow corresponds to that of the pumps.

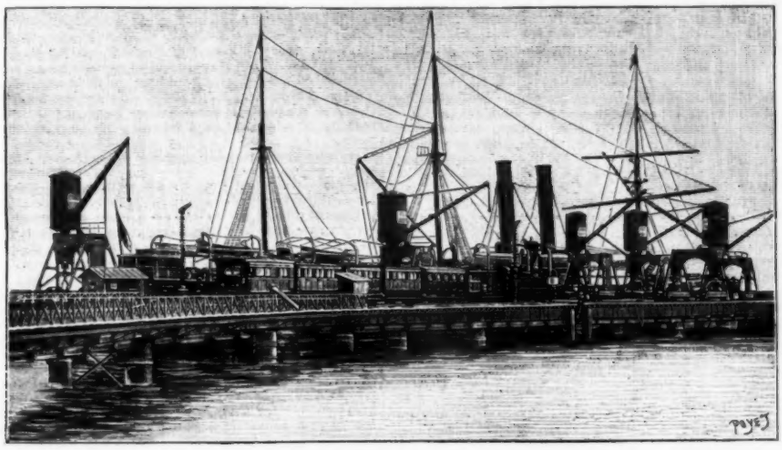


FIG. 4.—BOAT TAKING ON A LOAD, AND AN ARRIVAL OF A PASSENGER TRAIN.

The hydraulic cranes are 18 in number and of varying power. Nine are capable of operating at from 465 to 930 pounds, and the others at from 230 to 465 pounds to the square inch. The frame that carries them allows of the passage of an ordinary car between its uprights. This has permitted of laying two tracks more upon the pier. These tracks are five in number, and permit of carrying passengers and merchandise to every point and always within reach of the ship that is loading or unloading.

The land installations comprise, in addition to the machinery of which we have spoken above, a vast coal depot, a freight depot consisting of two immense twin structures covering an area of 27,000 square feet, covered and uncovered wharves, and numerous junction and shunting tracks.

A very comfortable station has been constructed for the Medoc Railway Company, at the society's expense. All the trains running in each direction stop here.

A boulevard, 5,850 ft. in length and 50 in width, connects the pier with Pauillac. It bears the name of Eugene-Pereire Boulevard.

Fig. 5 gives a general view of the installation, and of the railway station and the pier. The society owns a special installation at Bordeaux, which is very extensive. Upon a vast site of over 300,000 square feet, skirting the course of the Medoc, there have been established two covered buildings, one of them for outgoing and the other for incoming trains. The space comprises yards for cars and a complete system of tracks that connect with those of the Medoc Railway Company. All the travelers and all the freight start from here and are carried in one hour to the pier in a direct line.

This interesting installation is due to Mr. Eugene Pereire, who has been strongly seconded by Mr. A. De Vial, the society's manager. For the technical part, recourse has been had to the wise advice of Mr. A. Roboglia, ex-inspector general of bridges and railways. The work was executed under the surveillance of Mr. Allemandou, engineer of the society, by Messrs. Dayde & Pille.—La Nature.

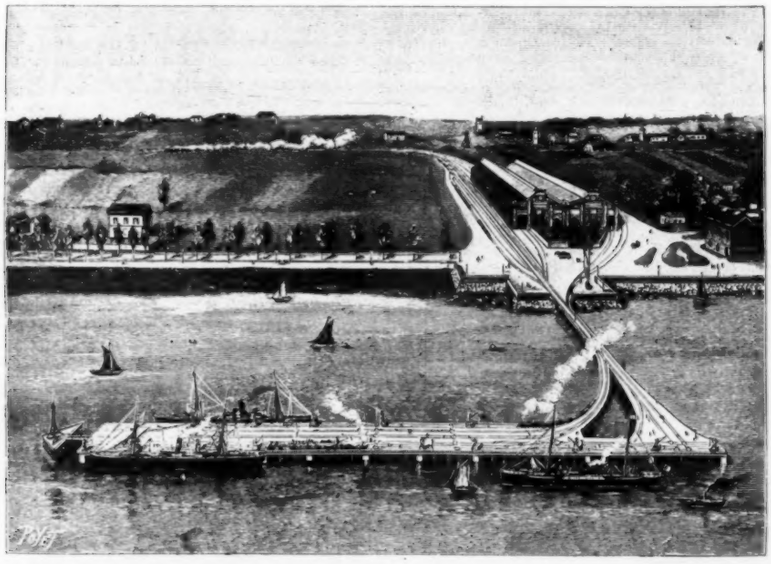


FIG. 5.—GENERAL VIEW OF THE ENTIRE INSTALLATION.

THE ELECTRIC LIGHT IN THE OPTICAL LANTERN.

By CECIL M. HEPWORTH.

IN the construction of an automatic lamp, the armature working between the two magnets is seldom connected directly with either carbon; it is more usual to let it actuate a brake, and to so arrange the carbons that they will come together by their own weight whenever the pressure of the brake is slackened, as it is when the arc gets too long and the current in the main magnet gets proportionately weak. But enough has been said to show what delicate mechanism is required in a satisfactory automatic lamp, and it will not be difficult to understand that such mechanism may easily get deranged in unskilled hands, and that pretty extensive electrical knowledge would be necessary before it could be put into order again. Such a lamp, of course, if properly made, is an expensive article, but it is not at all necessary.

A lantern must always have an operator in attendance upon it all the time it is at work, and a simple arrangement for holding the two carbons in such a manner that they can be conveniently fed together by hand at intervals whenever the distance between them is becoming too great is all that the lanternist requires; for this, hand regulation is only necessary once in every two minutes or thereabout, and is no more trouble than the turning of a lime. Besides, it is a very great advantage for the lanternist to have the whole thing under his own control, instead of being dependent on a number of factors whose working he cannot see, and probably would not understand if he could.

So much for the mechanism by which the carbons are held and the distance between their extremities duly regulated. We can now pass on to a consideration of the best positions of the carbons themselves, so that they should yield the greatest possible amount of light, and send it in the direction in which we require it to go for our particular purpose.

It must be remembered that the light emitted by the electric arc has, as it were, three separate sources of origin. First, and least brilliant of all, there is the actual arc itself—the band of light which marks the passage of the electric current across the space between the electrodes; secondly, there is the light from the incandescent point of the negative carbon; and thirdly, and by far the most important, there is the light from the crater of the positive carbon. For all practical purposes the two former need not be taken into consideration at all, for the small quantity of violet colored light which is due to the arc itself, although of great actinic power, photographically speaking, is in such insignificant proportion that it has little effect upon the total, while the incandescent negative point is also of but little account.

So it will be seen that we have to deal with a source of light—the crater at the end of the positive carbon—which is barely a quarter of an inch across, and it is not necessary to point out to lanternists that this is just about as near to the ideal of perfection in lantern illuminants as any that could be found. However, some means must be adopted for causing this little crater to take up its position on one side of the carbon rod so that its light should be projected into the lens system, and not all round equally as it is in an ordinary street lamp. The manner in which this consummation is brought about is simplicity itself.

The light-giving crater of the positive carbon, it must be remembered, forms at that point where the stream of electricity leaves it to jump across that space which separates it from the negative, and as electricity always chooses the path of least resistance, this jumping across occurs at those points of the two carbons that happen to be nearest to one another. Now, if the negative carbon is shifted about half its diameter in front of the other, the arc will form between the front edge of the positive and the back of the negative electrode. Consequently, the crater which always forms just opposite the nearest point of the latter will take up its position toward the front of the upper carbon, and, being tilted upward to a certain extent, will throw nearly all its light in the required direction. As a further aid toward the same consummation, the whole apparatus is generally tilted backward through a small angle, as shown in Fig. 1, where the forward displacement of the lower

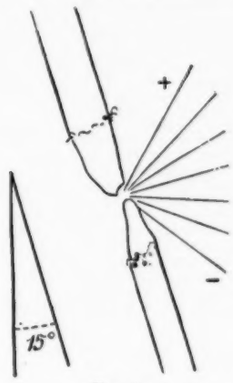


FIG. 1.

carbon with regard to the other and the position of the positive crater to give the most efficient results is also set forth. Different workers have different ideas as to the amount of backward tilting which it is best to give to the lamp, and, of course, the greater the rake or tilt, the less it will be necessary to displace the positive carbon behind the other, so that as a deficiency in either sense can, within reasonable limits, be remedied by a compensatory plenitude in the other, it is difficult to say what is the best balance of the two factors. However, when I experimented in this direction, I decided upon fifteen degrees of backward tilt as giving the best results in my hands, and I have never had any occasion to alter it. It should be noticed that too great a displacement of one carbon behind the other will seriously impair the steadiness of the light. It seems to me the tilt of the lamp should be as little as possible, provided it does not necessitate such a displacement of the carbons as to make the light burn unsteadily.

I have already said that the electricity in an arc lamp flows between the two nearest points of the carbons, and as it is at those points that the greatest amount of action occurs, it may be supposed that the consumption of the carbon is quickest in those places, and they will not long remain the nearest points. When they are burnt down to a certain extent, they naturally become further apart than the neighboring portions, and the arc, ever mindful of its path of least resistance, shifts round a little way and transfers its attention to another field, and when that, in its turn, becomes less eligible, yet another position is sought, and with every change, of course, the position and direction of the light is altered. In order to obviate this unsatisfactory state of affairs, it is usual to place in the center of the positive carbon a core of softer material, and this, burning more quickly and offering an easier path to the electricity, has the effect of causing the arc to retain its position in the center.

If all electricity supplied for the purposes of lighting were of the kind that is known as the continuous current, that is to say, electricity which always flows in one direction, from the positive to the negative, it would be very much better for the users of electric lanterns. Unfortunately for them, however, it is much more convenient to the electricians in many cases to install what they call the alternating current, which, as its name implies, is that in which the direction of flow is continually changing, and what at one moment is the positive electrode becomes in the next the negative—a change which occurs many times in a second.

As will be supposed, the result of this state of affairs is that the two carbons share between them the characteristics of both. Each burns away at an equal rate,

so that rods of equal diameter should be used. Each forms into a blunt point with a slight indication of a crater at the end, and the wandering about of the arc from place to place on the carbon ends is very noticeable. A similar precaution to that taken to obviate this fault in the case of the continuous current is resorted to, and both carbons are cored, with the result of very greatly improving the steady burning of the light, though not sufficiently so for lantern purposes. The slight tendency to wander around which the alternating arc retains even under the best of circumstances is not marked enough to be very noticeable in street lighting lamps, but in the lantern it has the distressing effect of varying the intensity of the light on the screen, which appears alternately to blaze up and sink away to half the brilliancy.

The ordinary alternating arc has another serious drawback as regards its utilization for lantern illumination. It has the nasty habit of casting a heavy purple shadow right across the center of the sheet, the reason for which defect will be seen by reference to the accompanying diagram, Fig. 2. In order to force the

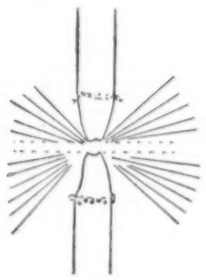


Fig. 2.

are to retain an approximately central position, as has already been said, cored carbons are used, and this remedy has the secondary effect of causing two deep craters to form at their ends, and it is from these two concavities that most of the light of the lamp emanates, the upper crater throwing all its light in a downward direction, while that from the lower one is all thrown upward. Consequently, there is no light at all in a horizontal direction except that from the outsides of the craters, which is very little, and the light of the actual arc itself, which is of a deep violet color. This is the reason of that violet band which is seen encircling the globes of all street lamps and the like which are run upon an alternating circuit. Another serious disadvantage of alternating arc lamps is the humming noise which always accompanies their burning, and which is produced by the very frequent change of direction of the current. Up to the present no cure has been found for this somewhat distressing complaint; but the noise is not loud enough to be of great importance in a hall of respectable size.

If the lamp be tilted backward through an angle of about thirty degrees, as in Fig. 3, all the light from the

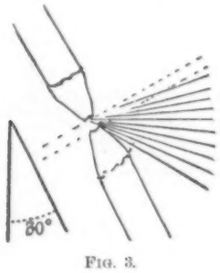


Fig. 3.

upper carbon will be projected through the lenses, and will yield a tolerably clear disk, but such a plan, of course, involves the entire loss of the light from the lower carbon, whose crater, being directed toward the back of the lantern, simply wastes its radiance on the desert air, so to speak. I have tried several experiments with electro magnets, magnetic helices, "shells," etc., with the idea of inducing the arc to take up its position toward the front edge of the carbons, and to stay there, for the ordinary electric arc is powerfully repelled by magnetic influence. However, the alternating current, as is its wont, refused to obey the laws which would have governed its more tractable brother, and my efforts were not satisfactory. The idea, of course, was to cause the arc to burn at the front edges of the carbons, so that they would be consumed faster at those places, with the effect of tilting the two craters away from one another, so to speak, in the front, so that all the light from each would be projected in that direction.

Then it was suggested by my father, Mr. T. C. Hepworth, that if special carbon rods were made with the soft core placed slightly to one side, that side, having thinner walls of the hard, slow-burning material, ought to burn quicker, or slightly in advance of the other side, and thus the crater would be tilted up toward the edge to which the core was nearest. He had a few carbons made on this principle, and the effect was so highly satisfactory in every way that it was made the subject of a patent. Two of these special carbons so placed in a lamp that their thinnest walls are nearest to the condenser will, under the action of the alternating current, quickly burn to the form shown in Fig. 4,

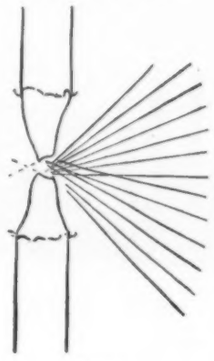


Fig. 4.

where it will be seen that practically all the light from both craters finds its way direct to the lenses, and, as a matter of fact, this diagram is not at all overdrawn, for by this method the alternating arc is very nearly as efficient for lantern work as its more straightforward rival, while the waste light from the back of the lamp is practically nil—it is hardly enough to cast a shadow at a few yards distance.

[Continued from Supplement, No. 1114, page 17814.]

THE SYNCHRONOGRAPH.

A NEW METHOD OF RAPIDLY TRANSMITTING INTELLIGENCE BY THE ALTERNATING CURRENT.*

By Albert Cushing Crehore and George Owen Squier.

THE POLARIZING RECEIVER.

The statement of the general principles employed in this receiver has previously been given, and it remains to describe the actual form. This instrument was designed for a military chronograph to measure the velocity of projectiles, and is known as the polarizing photochronograph.† A view of this is shown in Fig. 13.

Without giving a complete description of the instrument, which may be found in the Scientific American Supplement for January 2, 1897, it will suffice to describe its essential elements. A sensitive photographic plate 12 × 12 inches square is carried in a metal plate holder, which revolves in the wheel, W, driven by the motor, M. A powerful beam of light from the arc lamp, A, situated upon an inverted T rail, O', serving as an optical bench, is condensed by the lens, L_1, and passes through the polarizer, P, a Nicol prism, thence through the glass tube, T, containing liquid carbon bisulphide, and surrounded by a coil of wire, through the analyzer, A, a second Nicol prism. The light received through the analyzer is finally passed through a second lens, L', to focus the beam upon the horizontal radial slit in front of the moving sensitive plate. In its operation, the analyzer, A, is rotated until the light is completely extinguished, when no current is passing around the tube, T. The coil upon the tube is in circuit with the line from the transmitter, and the closing of the circuit at the transmitter thus sends a current around the tube, and light immediately appears upon the camera slit. This is accomplished instantly upon closing the circuit, without involving the motion of any material thing. Upon breaking the circuit the light immediately disappears, and by observing the light come and go, it is easy to read with the eye as rapidly as can be sent by hand. To produce a permanent record it is only necessary to rotate the photographic plate in the wheel, W. The time required by the photographic plate to make a clear record depends largely upon the intensity of the light; but the intensity of light which it is practicable to obtain allows the time of exposure to be much shorter than is required for the purpose of a telegraph receiver. For instance, suppose the width of slit is one millimeter at a distance of 150 millimeters from the center of revolution, and the plate rotates 1,000 times per minute, the velocity of a point on the plate is 1,570·8 cm. per second, and the exposure is, therefore, about 0·000063 second; for the point crosses the millimeter slit in this time. The above figures are those actually used with the chronograph in measuring the velocity of projectiles inside the bore of a gun, and the records obtained are perfectly clear. The rapidity of this receiver is illustrated by stating that as many as seven observations upon a projectile inside the bore of a United States 3·2 inch breech loading field rifle have been recorded in the first 57 centimeters (1 foot 10½ inches) of its travel, and observations as near together as 3·8 cm. (1½ inches) have been obtained. These correspond in time to intervals less than a thousandth of a second, or they bear about the same relation to a second as a second does to a third of an hour.

In chronography as applied to gunnery, since the agent which operates upon the transmitter circuit is the projectile itself, making and breaking the circuit by passing through screens, evidently if the screens are properly placed according to a code, a message could be transmitted to the receiver by a projectile in its flight.

THE CHEMICAL RECEIVER.

In a practical form of receiver, it is an advantage to have the messages received in such form that they are ready for immediate use, and this is the case with the chemical receiver to which reference has already been made.

Through the kindness of Mr. Delany, some of the sensitive paper tape used in his system of machine telegraphy was obtained for experiments with the synchronous transmitter. A simple method of obtaining records of currents with this tape, which is certain in its action and does not involve any special apparatus, is to place the tape upon a smooth metal surface, which serves as one electrode, and to draw a steel needle, serving as the other electrode, along it guided by the straight edge of a ruler. If a direct current is used, no record appears when the current is in one direction, and it does appear when the current is reversed. If a second needle is substituted for the plate electrode, the record appears on one side of the tape for a direct current and on the other side for the reversed current.

If the two needle electrodes are placed side by side upon the tape, a record will appear at one needle for a direct current and at the other for the reversed current. Employing the alternating current with the single needle and plate as electrodes, the record shows a regular succession of distinct marks, separated from each other by equal intervals. Each mark exhibits an intensity varying approximately according to the sine curve. Since by this arrangement the current makes its record in one direction only, the result is that alternate semicycles of the current are suppressed and alternate ones are recorded.

By receiving with two needles side by side, all the alternations are recorded, those that were suppressed before now appearing at the second needle. The record then appears as two parallel lines of marks having the maximum intensities in one line opposite the spaces in the other. Using the transmitter as already described with a semicycle as a unit in preparing the tape, and receiving in two lines, it is found that some of the marks are omitted in one line and some in the other, and to facilitate translating it is simpler to bring the two lines into coincidence to observe the dots and dashes of the message. A message was then prepared upon the transmitter wheel, using a complete cycle as a unit, instead of a semicycle. When received in a single line this message is complete, no matter to which terminal of the circuit the receiving needle is connected, because each unit now contains both a direct and a reversed current, one of which will record.

The same message was then received in two lines, and one line gave the complete message as before, while in the other line there appeared a record for each complete unit in which the current was made. The papers of either the first or the second half of each complete cycle composing the message upon the wheel were next removed, and the message received in two lines as before. The result showed the message complete in one line, while in the other line appeared an uninterrupted succession of marks just as given by the simple alternating current received in one line.

If then an uninterrupted line of marks can be received in one line at the same time that a message is being received in the other, this uninterrupted line can be used for a second message entirely independent of the first. The next experiment accomplished this, and it is now possible to use the same line to send two entirely independent messages in the same direction at the same time at a high rate of speed. The preparation of the transmitting tape to accomplish this simply requires that the two messages, each prepared with a double unit, shall be displaced a semicycle with respect to each other as they pass through the transmitter.

The advantages of duplexing the line, that is, sending two independent messages in opposite directions over one wire at the same time, seem more important than those of diplexing the line. An arrangement of circuits which accomplishes this proves to be very simple. Moreover, it permits entirely different frequencies to be employed by the transmitters at the two

*A paper presented at the 115th meeting of the American Institute of Electrical Engineers, New York and Chicago, April 21, 1897.

†"The New Polarizing Photochronograph," Crehore and Squier. John Wiley & Sons, New York, 1897. Chapman & Hall, Ltd., London.

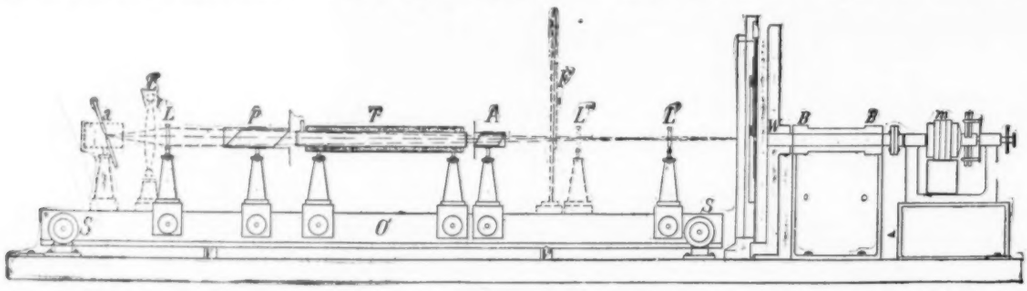


Fig. 13.—THE POLARIZING PHOTO-CHRONOGRAPH, UNITED STATES ARTILLERY SCHOOL, FORT MONROE, VA.

ends of the line, and, as before, involves no synchronous receiver at either end. By duplexing the line the speed of transmission over a single wire is practically doubled; for example, a line that carries 3,000 words simplex can carry 6,000 words per minute duplex.

It is desirable in many cases to manifold the original copies of the message received, and experiments were made to accomplish this. All that is necessary is to attach to one terminal, instead of a single needle, as many needles as the number of copies desired, having each make its record upon a sensitive surface. The manifolding process evidently applies to either simplex or duplex receiving. Manifold copies of messages may be received in widely different localities at the same time from one and the same transmitter, by connecting the receivers in series or in parallel.

The alternating current is adapted to use with condensers in series with the line where a direct current cannot ordinarily be employed. An experiment was carried out to send a message through a condenser having a capacity of 9·57 microfarads in series with the line, and it was found that the message was transmitted correctly. One object of this experiment was to establish the possibility of using a set of Morse instruments upon the line at the same time that the messages were being transmitted at a high rate of speed by the alternating current. By shunting condensers around the set of Morse instruments it was found that the operation of either system did not affect the working of the other, so that it becomes possible to use the same high speed line for a complete system of quadruplex telegraphy at the same time. Indeed, it seems possible that the present Wheatstone system could be operated over the line in conjunction with the alternating current messages. The experiments with the chemical tape which have been outlined above, together with others not here given, demonstrate the flexibility of a system of intelligence transmission employing the alternating current.

The use of the alternating current as a means of sending intelligence, in connection with the fact that a message can be sent through condensers, suggests the possibility of using the principles of electric resonance employing circuits having natural periods of their own which will pick out and respond to currents from the line having their own frequency.

Although the above illustrations have employed for the most part the Continental code representing a dot and a dash in a particular manner by the omission of certain waves, and the spaces between letters and words by the presence of waves, yet it is evident that this is but one of many combinations which this system permits, and that mentioned above is not to be understood as representing the most desirable one.

A characteristic of the records made by electrolysis is the natural separation of the positive and negative waves of current, which is an advantage in interpretation. This separation is also accomplished in the polarizing receiver by employing two receiver tubes. Instead of setting the polarizer and analyzer for extinction, they are so placed that some light is normally transmitted through each tube. The tube coils are so connected that a positive current produces approximate extinction in one tube and a maximum transmission of light through the other. A negative current transmits a maximum of light through the first tube and produces approximate extinction in the second. An alternating current therefore causes a record of the positive waves through one tube, and the negative waves through the other, and thus accomplishes all in this respect that the chemical receiver does.

THE LINE.

It is generally understood that the line limits the speed of telegraphy. The limit is usually reached because of the distributed electrostatic capacity of the line rather than its resistance. The influence of the distributed capacity is to change the form of the wave as well as reduce its amplitude. With a given length of line having a certain static capacity, there exist limits to the speed obtainable with any given set of instruments which would be a difficult mathematical problem to predetermine. The difficulty in making this calculation is in the influence exerted by the particular instruments used. With different instruments the upper limit of speed is very different with the same line. It therefore seems that the only way to determine this question is by submitting the system to actual trial over a long line.

In order to test this system over as long a line as was available, the land telegraph and telephone lines upon the military reservation at Fort Monroe were joined in series, making about thirteen miles of iron wire having a resistance of 320 ohms. Not only was no difficulty experienced in transmitting and receiving messages over this line, but resistance was introduced making about 1,500 ohms total, including the polarizing receiver coil of 390 ohms. This trial was at a frequency of about 200 complete periods per second. With the chemical receiver a coil of 10,900 ohms was used in the laboratory and the record was plainly received at a frequency of about 545 complete periods per second.

CONCLUSION.

When the extent of the transmission of intelligence at the present time is considered, and the direct influence which this service has upon the development of the world's progress, any proposition which promises to increase its efficiency should be received with consideration.

It is noticed in general that there is an increase in all departments of the intelligence transmission service from the earliest dates. The number of pieces of mail sent during 1896 was 5,693,000,000, which is the greatest amount ever sent in a single year. The greatest number of telephone messages on record for a single year is 757,000,000 in 1895. The largest number of telegraph messages was sent in 1893 and amounted to 66,000,000. Thus the greatest number of telegraph messages as compared with telephone messages is in the ratio of 1 to 11½. The greatest number of pieces of mail is in the ratio of 86 to 1 as compared with telegraph messages, or in the ratio of 7⅛ to 1 as compared with telephone messages. It is also seen that the cost of the mail service of the United States in 1896 was $90,626,000, or about $1.25 per capita. The greatest receipts for any year of the American Bell Telephone Company were in 1895, $16,400,000, about 25 cents per capita, while the greatest receipts of the Western Union Telegraph Company were in 1893, $24,978,000, about 35 cents per capita.

It appears therefore that the people of the United States pay, for a telegraph service of about ⅛ the amount, about one-fourth of that paid for the entire mail service of the United States. It also costs one and a half times as much for telegraph service as for the telephone service, although the number of telephone messages is about eleven and a half times as great.

A conclusion to be drawn from the above general data seems to be that the people are willing to pay more in proportion for a kind of service like that of the telegraph than any other. From the point of serving the people, as well as from a business standpoint, it appears that improvement in this class of intelligence transmission is at present much to be desired. The present state of the art of telegraphy points to improvements along the line of automatic machine transmission.

It is of interest to inquire what effects a system of telegraphy capable of sending continuously 3,000 words a minute would have on the existing methods. To take a single example of the business between New York and Chicago, where about 40,000 letters are carried daily, it would require but two lines in continuous operation to handle the entire business. At present it takes three days to receive a business reply between New York and Chicago. This transmission by machine telegraphy could be accomplished easily the same day. It is thought that an effect of this would be to increase business transactions to such an extent that the total volume of intelligence transmitted would be augmented, rather than to diminish the business now done by existing methods.

The class of business which such a system would probably at first obtain would be the less urgent telegraph business of greater volume, such as the Associated Press dispatches and newspaper press reports. Among the possibilities is the simultaneous publication of the same newspaper in different parts of the country. For example, in an edition of a daily paper having twelve pages and eight columns per page, making ninety-six columns in all, there are less than 185,000 words. At the rate of 3,000 words per minute it would only require about an hour to transmit the entire contents of the paper. This calculation furthermore assumes that the whole paper is uniformly printed in fine type. It would require a single operator, working by hand and averaging twenty words per minute, over six days of twenty-four hours each to send this amount.

The system proposed in this paper is especially adapted to meet the demands of this class of business; for the great flexibility of the alternating current as employed permits, if necessary, considerable amounts of power to be transmitted over the line which may be used for making simultaneous manifold copies of the same dispatches in each of widely separated cities. In this manner each of the several newspaper company subscribers in each city receives the identical service with the minimum delay, since each copy received is an original. Each additional subscriber to this service represents no appreciable expense to the company, since it requires but another receiving needle. Furthermore, the use of the alternating current permits the line to be used quadruplex at very rapid speeds, that is, four entirely different dispatches may be sent over one wire at the same time, two in each direction, and any number of copies of one or all the dispatches may be received independently at the same time.

In addition to the above it is practicable to employ the line for a system of the ordinary quadruplex telegraphy at the same time. In trial experiments in the laboratory, particular instructions were given to the operator of the Morse instrument to observe if possible when the messages were being sent by the alternating current, and absolutely no effect was detected.

The objection may be urged that it is already difficult to handle the business at the present rate of operation of the Wheatstone system, and if the instruments worked faster it could not be handled. This objection is undoubtedly a real one in some cases, and it is partly this fact which indicates that it may be easier to inaugurate new methods than to attempt to adapt the new rapid transmitters to the present methods.

A telegraph office of the future will probably present a different appearance from that which may now be seen in any of the large cities. At present in operating the Wheatstone system in this country, sending to long distances at the rate of 150 to 200 words per minute, both those who prepare the sending tape and those who translate the receiving tape are employes of the telegraph company and are near the sending and receiving instruments. If it requires about ten men to prepare tape, and as many more to translate it for a single instrument operating at 150 words per minute, it will require twenty times this working force for one of the rapid machine transmitters. Evidently changes would be required in the present methods to handle this business.

It is thought that a telegraph company of the future will fulfill a somewhat different function from the present ones. The company will own its wires and rights of way as now, but the tendency of the offices proper will be to transmit and receive letters already prepared, rather than to undertake the preparation of the letters as well. The income of the company will be derived from the rent of its lines at a fixed price per minute, or a fixed price per hundred words. The service of the telegraph office then becomes like that of the post office, its duty being to receive and deliver letters already prepared, as the post office does. The difference between the two offices is in the manner in which this is accomplished. The telegraph office becomes a post office which employs an electric current in a copper wire to carry its letters instead of a railroad train. The advantages in point of speed of delivering letters by the former method are apparent. Instead of requiring twenty-four hours to deliver letters between New York and Chicago, it will require but a few hours at most, and make it possible to receive a reply the same day. It is probable that such a system would take more business from the present postal system than any other; for when telegraph letters can be sent at reasonable rates comparable with postage, in a few hours instead of many days, a certain amount of present post office business will be diverted. More than this, when business can be done with greater facility than at present, the total volume of business will undoubtedly be increased, because transactions may take place in a day which formerly required a week.

It would be to the interest of such a company to seek that class of less urgent business now done by correspondence, rather than the class handled by the present telegraph companies, where the highest speed of delivery is expected. If one trunk line becomes established between large business centers, it will draw business from a surrounding area. For instance, if a line were established between New York and Chicago, and a person in Albany desired to communicate with Chicago or points beyond, it would be quicker to send the letter to New York for transmission over the trunk line to Chicago, and then by rail to its destination, than to send directly by rail from Albany. With a few trunk lines in successful operation it would not be long before they would be multiplied.

It is understood that these telegraph letters are sent by mail in envelopes in the usual manner, except that the envelope contains the prepared message ready to be sent through the transmitter, and thus the telegraph office becomes relieved of the preparation of the letters, which is not strictly a part of its business. When the system comes into general use, business offices will have their own perforators, and it will become necessary for the operator to learn the telegraph alphabet as a part of his preparation as a stenographer and typewriter. The three-key perforating machine is comparatively inexpensive, but undoubtedly a machine could be devised at an early date, as an attachment to the present typewriter, for the purpose of perforating letters at the same time that they are being written by the typewriter in the usual way. This could be constructed to operate by the use of electromagnets, and can be attached to a typewriter without interfering in any way with its operation. No extra power would be required, for this can be derived from an electric current which operates the attachment. The writing may be perforated at the present rate of speed of typewriting without the operator having any knowledge of the telegraph alphabet as far as perforating is concerned. This machine will cost more than the three-key perforator, but it would in a short time more than pay for the difference in cost on account of the great gain in speed, and also because it prints a copy of the letter which may be kept on file. Before these perforators are introduced into common use it will be necessary to establish offices in the immediate vicinity of the terminals of the trunk lines, to prepare letters for persons furnishing printed or written copy, as well as to furnish a printed translation when desired of letters received from the central office. The opportunity to obtain a cheaper rate for prepared letters will act as an inducement to those employing a stenographer to add a perforator to their offices.

Concerning the daily correspondence of the large business houses between cities which are the terminals of the trunk lines, it might be an advantage for them to have exclusive use of the line for a certain number of minutes daily at a certain fixed time of day, by subscribing and paying an annual rental to the company. Knowing definitely at what hour the mail would be dispatched daily, it would then be possible for each house to send by messenger its daily mail already prepared for transmission to the general transmission office, where it could be placed in boxes prepared for the subscribers, to be taken out and transmitted when its time arrives. The distribution at the receiving end of the line could be accomplished as now by the regular mail service.

In the limited use of rapid automatic intelligence transmission at present, the sending and receiving records are made upon prepared paper in the form of tape. In the larger volume of business which is being considered here, it does not seem certain that tape would be the best form for the sending and receiving paper. It would be an advantage to have the letters received upon sheets of paper with the dots and dashes arranged in parallel lines. Besides facilitating the reading, this form would be more convenient for mailing. It would also easily permit reference to any part of the letter at a glance. The amount of paper required by the use of sheet form instead of tape would be reduced, which is an item of importance where such a volume of business is being handled. Sending and receiving from the surface of a cylinder seems entirely practicable.

Another point which must be considered is whether with these systems the induced currents from neighboring wires along the line or from any other cause will affect the legitimate signals materially, as has been at times the case with the Wheatstone system. In reply to this it can be said that these receivers for telegraphy are not necessarily more sensitive to small currents because they are rapid. On the contrary, they may be made to require as much current as is found desirable to rid them of the effects of outside influences, and at the same time retain the property of quick action in response to currents of the proper magnitude. In this connection it may be said that the utility of a single line wire becomes so great that more attention will be given in the future to the line construction and maintenance. If millions of dollars are invested in the construction of a single railroad, is it not necessary to make the telegraph lines which carry important and profitable business as perfect in their construction?

The telegraph line of the future will comprise substantial poles carrying a few copper wires worked to their full capacity for transmitting electric signals. The cost of maintenance of such a line when once constructed will be little more than for an ordinary iron wire now used, while its carrying capacity for intelligence at 3,000 words per minute simplex will be about equal to 160 wires used for hand transmission simplex.

By duplexing the line, the carrying capacity is doubled and becomes 6,000 words per minute, which is about equal to 160 wires worked duplex, or to 80 wires worked by hand quadruplex.

It is thought that the influence which the inauguration of a telegraph letter system would have upon the existing telegraph and telephone business would be to increase rather than diminish it. Each of these services has its own special field of usefulness but little affected by the others. A new field would be occupied rather than an old field supplanted. The present telegraph and telephone would still have their natural field of operation, even though the best hopes for a telegraph letter service are realized.

A single line capable of sending 6,000 words per minute between New York and Chicago becomes a different kind of investment from a long distance telephone line where the number of words per minute with the fastest rate a speaker can talk is very slow in comparison, and the charge is $9 for five minutes' use of this line.

The application under government control of a rapid system of correspondence transmission such as has been outlined, operating in conjunction with the present postal system, by supplementing and relieving their service could hardly fail to prove of benefit to the people of the United States. This comes within the proper duty of the Post Office Department, and would be under the direct control of the Postmaster-General. The simplification in operation and expense which would result from uniting directly with the general post offices of large cities the telegraph letter service would soon be realized by the people and a better service insured.

As a practical means toward ultimately assuming the direct responsibility of this new service, it would probably be easy to secure private companies which would be willing to contract with the Post Office Department to transmit telegraph letters at a fixed rate for a term of years. In this manner the department could gradually absorb this branch of its business and be relieved of any sudden new responsibility and radical reorganization.

It is not thought that the development of a rapid intelligence transmission service to the extent suggested could be accomplished before many years, nor indeed that the manner or means of this development should closely follow the lines indicated, but that something analogous to this development seems among the possibilities, if not the probabilities, of the near future.

The persistent efforts of Mr. Delany and the great system which he has developed are well known, and the ideas which he has advanced in regard to the applications of rapid systems are in the main in accordance with those stated herein.

ELECTRO-GERMINATION.*

By ASA S. KINNEY.

FOR the past century and a half scientists have been at work upon the relation of electricity to plant life, and still the literature which we have upon the subject is extremely limited and widely scattered. Many of the results obtained along this line have never been recorded, and others which have been published from time to time would seem to point in a negative direction, while a very few have been so encouraging as to offer inducement for further investigation in this line.

Several years ago N. Specnew succeeded in very perceptibly hastening the germination of the seeds of beans, pease, barley, sunflowers, etc., by treating them with an electric current, but since then other investigators have failed to fully substantiate these results, and it is owing to the widely varying conclusions which have been drawn that the following experiments were carried out. In this work the object has been threefold. First, to determine whether the seed germ responded in any way when subjected to electric influence. Second, should there be any visible action, to determine whether it was injurious or beneficial. Third, to determine the effect of different strengths of current. The experiments have been carried on from a scientific standpoint rather than any practical use to which they may be put, although with proper apparatus electricity may prove of considerable service in the germination of some small seeds, which under ordinary conditions start slowly.

* Abstract of Bulletin No. 43 of the Hatch Experiment Station of the Massachusetts Agricultural College, Amherst, Mass.

APPARATUS AND METHODS.

The kinds of apparatus and the methods described are those which gave the best results, while others, employed at first, but found unsatisfactory, have not been considered.

The batteries used in the experiments were of two kinds, namely, four Leclanché cells arranged in series giving an electromotive force of from four to five volts and two No. 1 Samson cells giving an electromotive force of two and eighty-eight hundredths volts. Had long periods of treatment been desired, gravity cells would have answered the purpose much better, but as the current was never used for more than five minutes at a time and then the battery allowed a period of rest, no difficulty was experienced from its running down, and a comparatively constant strength of current could be obtained. The great advantage gained in using the sal ammoniac battery is the ease with which it may be set up and renewed when exhausted.

In order that a large variation in electromotive force could be obtained, an induction coil was employed. The one in use was a Du Bois Reymond inductorium, manufactured by the Cambridge Scientific Instrument Company, England. This coil is a form of the Ruhmkorff apparatus, but has several special modifications which make it especially adapted to this form of experiment. In Fig. 1 there is shown at I a side view of the coil as it is set up for use. The primary coil, C,

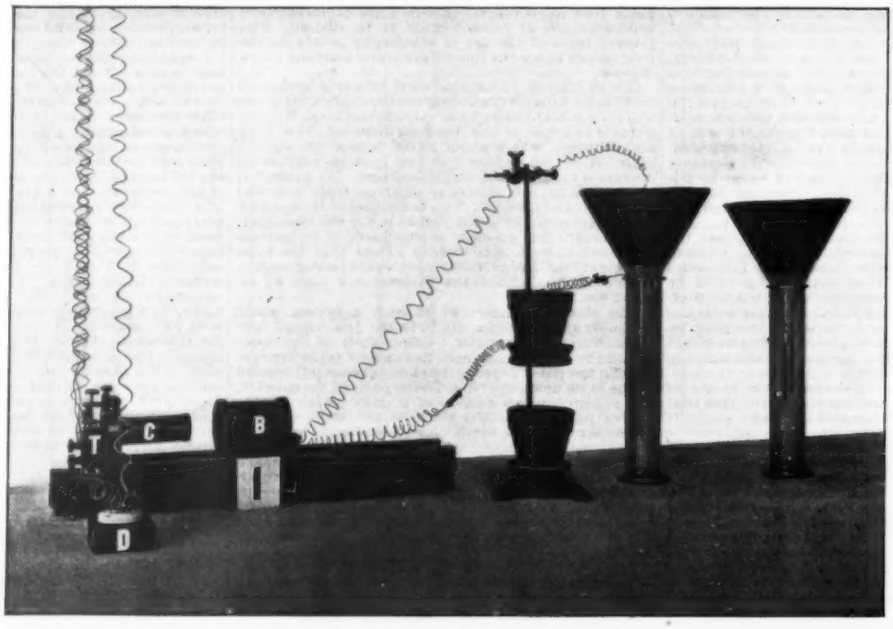


FIG. 1.—APPARATUS FOR TESTING ELECTRO-GERMINATION.

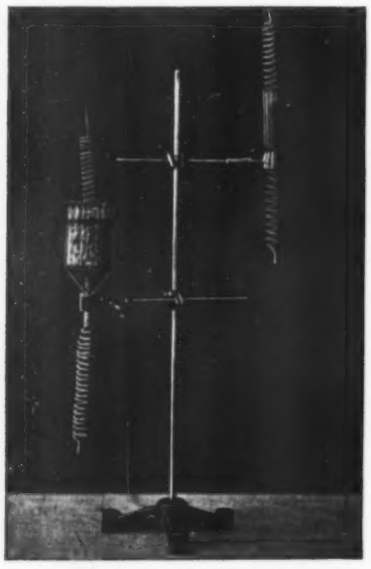


FIG. 2.—APPARATUS FOR THE TREATMENT OF SEEDS.

FIG. 3.—ENLARGED VIEW OF THE GLASS CHAMBERS AND FUNNELS.

consisting of a core of soft iron rods, is fixed and wound with about one hundred and thirty turns of moderately thick insulated copper wire. The secondary coil, B, having six thousand turns of fine copper wire, is quite separate from the primary coil and slides in a groove in the wooden standard. In this way the secondary coil may be brought over the primary coil or removed quite a distance from it.

In some of the experiments, hourly treatment was desired. This was accomplished by passing the wires from the battery to an electric clock and thence to the induction machine. Each hour the clock formed a connection completing the circuit and a current was passed through for a period of about thirty seconds.

Methods of Applying the Stimulation.—In Fig. 2 is shown the apparatus most frequently used in the treatment of the seeds. This consists of two glass cylinders, a larger one about two inches in diameter for large

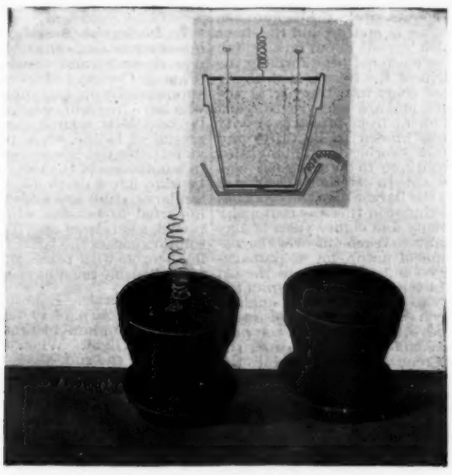


FIG. 4.—FLOWER POTS MAY BE USED INSTEAD OF GLASS FUNNELS.

seeds and a smaller about three-fourths of an inch in diameter for those of less size. Within these cylinders thoroughly moistened seeds were placed and the openings closed with copper disks having wires attached. By means of these wires the disks were connected with the poles of the induction coil and a current passed through, the moist seeds making a moderately good conductor.

Another method of applying the stimulation is shown in Fig. 3. This consists of two seven-inch glass funnels. Within each of these funnels are two copper disks, a small one at the bottom and a larger one at the top. In the upper disk of each funnel are twelve holes, at equal intervals around the edge, to allow the hypocotyls to grow through. Between the disks of each funnel is placed a layer of moist sand in which the seeds are planted. To the disks of one funnel are attached wires, by means of which they are connected with the poles of the induction coil. In this way a current may be passed through the moistened sand, which acts as a good conductor.

The object of taking a funnel rather than a cylinder is that the action of gravity constantly draws the roots against the glass, allowing measurements to be taken from the outside, whereas, were the sides vertical, nutation and such forces as hydrotropism might cause the root to grow inward and away from the glass.

In experiments with this apparatus the seeds were

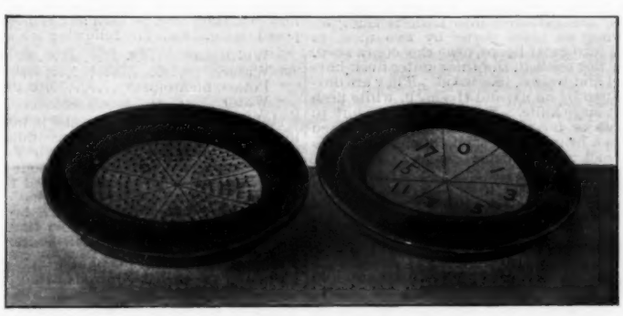


FIG. 5.—METHOD OF SOWING THE SEEDS ON FILTER PAPER.

first germinated in sawdust and when the radicles had reached a length of about two centimeters they were removed to the funnels, where the subsequent growths of the normal and stimulated plants were compared.

In Fig. 4 is shown an apparatus very similar to that in Fig. 3 with the exception that in this case four-inch clay pots were substituted for the funnels.

This apparatus is not adapted for observation of root growth, but simply that of the stems. In the upper disks are seven holes through which the young seedlings grow, as shown in the diagram in Fig. 4, which represents a cross section of the pot where the plants were treated with electricity.

GERMINATING APPARATUS.

In the selection of germinating pans for this work two chief points have been taken into consideration. First, that the normal or untreated seeds should have exactly the same environments as those treated, aside from the conditions brought about by the application of electricity. Second, that the conditions for germination should be as favorable as possible, that is, that there should be the proper amount of heat, air and moisture to give the best possible conditions.

The form of apparatus which was used in these experiments and which seems to fulfill the requirements very well is shown in Fig. 5. This consists of two plates, an outer of porcelain about nine inches in diameter and an inner of clay seven inches in diameter. Within the inner plate filter paper is placed upon which the seeds are sown. In the outer plate a constant supply of water is kept which gradually passes through the plate of porous clay, keeping the filter paper within constantly moist. The seeds are sown upon the filter paper in the manner shown in the left hand pan in Fig. 5. The paper is divided into eight equal parts; seven of these are used for the treated seeds, while the eighth or 0 is for the normal or untreated seeds.

A second piece of moist filter paper is placed over the seeds, resting upon them and touching at various points the paper beneath. In this manner the covering is kept moist by absorption. A plate prepared for germination is shown at the right in Fig. 5. In order to insure perfect darkness a piece of black cardboard was placed over the pan in such a manner as to shut out the light, but not prevent a free circulation of air.

In this form of pan the young plants can be grown without difficulty until the hypocotyls are two or three centimeters long. The moist filter paper, which constitutes the covering of the seeds, offering but little obstruction to growth.

(To be continued.)

EXPERIMENTS UPON METABOLISM IN THE HUMAN BODY, UNDER THE DIRECTION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

THE Department of Agriculture has received and is about to publish the details of the experiments on the nutrition of man, the brief reports of which have lately excited so much interest in different parts of the country. These experiments are carried out, under the auspices of the Department of Agriculture, at Wesleyan University, in Connecticut, in co-operation with the Storrs Experiment Station. They belong to a series of inquiries upon the economy of food and nutrition which are being prosecuted in co-operation with universities, college settlements and benevolent associations in different parts of the country. The special objects and methods of the experiments in Connecticut are referred to by Professor Atwater, special agent of the department in charge of nutrition investigations, as follows:

"Research upon nutrition has brought us to the point where the study of the application of the laws of the conservation of matter and of energy in the living organism are essential. For this purpose a respiration calorimeter is being devised. This is an apparatus in which an animal or a man may be placed for a number of hours or days, and the amounts and composition of the excreta, solid, liquid and gaseous; the amounts and composition of the food and drink and inhaled air; the potential energy of the materials taken into the body and given off from it; the quantity of heat radiated from the body, and the mechanical equivalent of the muscular work done, are all to be measured."

This apparatus includes a so-called respiration chamber. This is practically a box with copper lining. It is 7 feet long, 4 feet wide and 6½ feet high, large enough for a man to live in. It is provided with glass doors, through which the subject enters; and with a chair, table and cot bed. A current of air sufficient for ventilation passes through the box. Arrangements are made for passing in the food and drink and removing the excretory products. The food, drink and excretory products are all carefully weighed, measured and subjected to chemical analysis. The ventilating current of air is measured and analyzed. In this way it is possible to learn just what materials are taken into the body and what are removed from it. Arrangements are also made for regulating the temperature inside the chamber. In these experiments cold water is passed through tubes in the respiration chamber. These tubes act as absorbers, the heat given off from the body being taken up and carried away by the current of cold water. In this manner the temperature is kept at a point which is comfortable for the occupant at all times. This is the reverse of the system followed in heating houses by means of hot water passed through radiators from which the heat is given off into the rooms. A man can remain in the respiration chamber an indefinite time without particular inconvenience. The experiments thus far made have been of from 2½ to 12 days' duration. The assistant who remained in the chamber during the longest experiment experienced so little inconvenience that he is by no means unwilling to undertake the same task during a period of even longer duration. Observers are at hand day and night. They not only attend to the wants of the subject and supply him with food and drink, but also make the weighings, measurements and analyses needed for the experiment.

THE EXPERIMENTS AND THEIR RESULTS.

These can be best explained by first describing the diet and its nutritive ingredients and then referring to the effects of the food upon the body of the subject. Facts drawn from several of the experiments will be used for this purpose. The first experiment was made with a laboratory janitor. He was a Swede about thirty years old and weighed, without clothing, 148 pounds. He was accustomed to rather active muscular labor, and previous experiments had shown him to be a decidedly "hearty" eater. He remained two and one-fourth days in the apparatus. He drank water ad libitum. His daily food was as follows:

	Ounces.
Cooked meat	4·3
Eggs	3·5
Potatoes	5·3
Bread	8·8
Milk crackers	3·5
Butter	1·1
Cheese	2·7
Milk	35·1
Sugar	0·8
Coffee	10·5
Total	75·6

During the experiment the subject did no work; he read a little, but had extremely little muscular exercise. The diet was necessarily simple, because of the labor required for the preparation, measurement and analysis of the foods. It was, however, entirely agreeable to the subject and the quantities were such as he chose. In estimating the quantities of nutritive ingredients of the food it is customary to take into account the protein, fats and carbohydrates and the potential energy or fuel value. The protein compounds which occur, for example, in the lean of meat, white of egg, casein of milk, gluten of wheat, are the so-called tissue-forming substances. They make blood and muscle, bone and brain. The fats include the fat of meat, the fat of butter and milk, the oil of wheat, etc. The carbohydrates are the sugars and starches, such as the starch of bread and potatoes and ordinary sugar. The fuel values are estimated in heat units or calories. The fats and carbohydrates are the chief fuel ingredients of the body, although the protein compounds serve to some extent as fuel. But while the protein compounds can do the work of the fats and carbohydrates in supplying fuel for warmth for the body and for its muscular work, neither fats nor carbohydrates can take the place of the protein in building and repairing the tissues of the body. In considering the nutritive ingredients of the food, therefore, we have to take into account the amounts of protein and the fuel values. The daily diet used in this experiment was found to furnish, in digestible form, 4·8 ounces of protein and 2,960 calories of energy. It may be added that coffee, like tea, contains practically no nutrients, except those of the milk and sugar used with it.

Taking into account the food and excreta, it is possible to calculate how much protein or fat the body gained or lost per day during the experiment. In the experiment with the diet referred to, the man's body gained about half an ounce of protein and two and one-tenth ounces of fat per day. This shows that the diet was more abundant than was required for the maintenance of his body. In other words, he was supplied with more protein and fuel ingredients than he required. This was not surprising, since during the period of the experiment he performed practically no muscular work, while his diet had been selected in accordance with his ordinary eating habits when he was engaged in his daily labor.

In a second experiment with the same man the diet was reduced, mainly by diminishing the amount of milk from about one quart to one pint per day. The protein was thus reduced to 3·9 ounces and the fuel value of the digested nutrients to 2,650 calories. With this diet the body almost exactly held its own as regards protein, but still gained a small quantity of fat, about half an ounce per day, showing that the food still exceeded the amount needed to supply the wants of the man's body when he was practically at rest. It

was calculated that if the amounts of milk, potatoes and butter in his diet had been reduced by one-half, the nutrients would have just sufficed to meet his needs under the conditions of the experiment.

In another experiment, which is the most interesting of all, the subject was a young man 23 years of age, rather taller than the laboratory janitor, quite muscular, and weighing 168 pounds without clothing. He had been accustomed for a number of years to school and college life, and later to the work of an assistant in the college laboratory. This occupation involved but little muscular activity. Previous experiments had shown that he was inclined to eat rather small quantities of food. His daily diet during the experiment was of his own choosing as in the former case. The food materials were as follows:

	Ounces.
Cooked beef	3·4
Mashed potatoes	3·5
White bread	5·4
Brown bread	8·8
Oatmeal	1·5
Beans	4·3
Butter	1·6
Milk	22 9
Sugar	0·6
Apples	4·3
Total	56·3

The experiment showed that he digested from this food on the average about 3·3 ounces of protein and with it enough fats and carbohydrates to make the fuel value of the digested food 2,500 calories per day.

The experiment was divided into five periods. During the first period (1½ days) and the fifth (1⅔ days) the subject was at rest. He passed more or less of the time in reading, but did nothing to require any considerable exercise of either muscle or brain. The second, third and fourth periods were of 3 days each. During the second period he engaged in severe mental work, partly in calculating the results of experiments and partly in studying a German treatise on physics. The third period was one of absolute rest. The subject sat in his chair or reclined upon the cot bed, but did no reading and moved about as little as possible. In the fourth period he performed severe muscular exercise. During eight hours of each of the three days he was engaged in raising and lowering a heavy weight which was suspended by a cord passing over a pulley at the top of the chamber. The work in this case was so severe that he was thoroughly exhausted.

The results showed that the subject during the periods of rest gained about half an ounce of protein and lost not far from the same quantity of fat daily. The diet which was roughly calculated in advance to be very nearly sufficient for the needs of the organism when no considerable amount of work was done proved to have a slight excess of protein and not quite enough fats and carbohydrates. With the severe mental work the results were almost exactly the same. During the three days of hard study the organism consumed about the same quantities of nutrients as when it was at rest. Whether this would prove true for a longer period is not certain.

During the period of hard muscular work the results were quite different. As was to be expected, the food did not suffice for the demands of the body. Instead of gaining one-half an ounce, the organism lost about one-sixth of an ounce of protein per day, while the loss of fat reached 6·9 ounces. The fuel value of the materials consumed in the body during the periods of rest and of mental work ranged from 2,600 to 2,700 calories per day, but in the period of muscular work it rose to 4,325 calories. In this case, therefore, the severe muscular work increased the consumption of protein by over half an ounce and the consumption of fats by more than seven ounces per day. The experimenters have estimated the changes which would have been needed in the daily food to make it equal to the demands of the body during the period of muscular work. They calculate, for instance, that if the daily food had been increased by doubling the butter and sugar and adding half a pound of bacon, it would have been sufficient.

The chief interest of these experiments from the practical standpoint is the light they throw upon the ways the food is used in the body and the kinds and amounts that are appropriate for people of different occupations and under different circumstances. Physicians tell us that disease is largely due to errors in diet. It is only by such researches that the exact knowledge can be acquired which is needed to show how our diet can be fitted to the demands of health and strength as well as purse. In addition, the experiments have great scientific interest.

A number of experiments of this kind have been made in Europe, but these are the first in the United States. These investigations are being continued by the Department of Agriculture, and further reports may be expected from time to time.

Thus far we have described only those features of these investigations which included the measurement of the income and outgo of matter and the determination of the fuel value of the food. The fuel value of excretory products was also determined, as well as the energy manifested by the body in the form of heat or external muscular work. For the measurement of the body's energy delicate and elaborate apparatus was devised. Highly interesting results have already been obtained, but so many improvements in the methods and apparatus have suggested themselves during the progress of the work that it has not been deemed advisable to publish the details of this part of the investigation at present.

We are indebted to our esteemed contemporary Science for the above particulars.

COCOANUT CULTIVATION IN SAMOA.

THE single exportable staple for which Samoa is eminently adapted, and the one upon which all its business at present rests, is the cocoanut (Cocos nucifera). It is to Samoa what cotton and corn are to the United States; all that grain, meat, and wool are to the Australian colonies. The export of the copra alone, save with trifling and inappreciable exception, represents the entire agricultural productive capacity of Samoa, and through this source all the money that trade and commerce bring into the islands finds its way.

The United States consul-general at Apia says that if the cocoanut crop were an absolute failure for a single year, the entire export of the kingdom would not amount to more than £1,200, and this illustration will adequately represent the prime importance of this single article to the country and its needs. The accepted method is to plant the cocoanuts in rows forty feet apart, setting the trees thirty feet in the row. The cocoanut loves the sunshine and free circulation of the air, and to flourish in perfection it should stand on the outer verge of the shore, its roots striking into the sea water, its branches or palms tossing in the breeze.

The lowlands of the beach in the Samoan Islands are more or less covered with the groves, while on the mountains or highlands no tree is found. The smaller size of the trees and the poorer yield is plainly to be noticed on lands at an elevation of from 400 to 600 feet, situated at as short a distance as two and a half and three miles from the shore. Standing immediately on the beach, the tree inclines outward over the water; growing inland, it points by its leaning in the most direct way to the sea. The nuts ripen throughout the year, hanging in clusters close in and around the stems of the palm branches, which spread about on all sides, and reach upward from the clustered head forming the top of the tree. The height of the trees is from thirty to eighty feet. The trees come into bearing at the sixth year on suitable soil, and are believed to reach the full limit of production at from fifteen to twenty years of age. Many groves known to be thirty and forty years of age are now bearing in undiminished abundance, and they so continue to do to a great age. Persons who profess to be able to determine the age of trees by the marks left on the bark where the branches have successively fallen estimate in this way that many still vigorous trees are seventy and eighty years of age.

The habit of the cocoanut to reach out over the water seems to be a provision of nature for its propagation and distribution. The nuts falling into the sea will float for weeks in the bitterly brackish waters of the tropic seas without injury to the germinating quality. Once thrown upon the warm sands of a beach or tossed by a wave upon a reef above the surface, it soon puts forth its palm from the smaller end, while from the round and larger end the tender roots strike into the soil or decayed coral, as the case may be. Many lagoons which have risen within living memory, and which for years remained without sign of vegetation, are now covered with the cocoanut, although hundreds of miles from other islands. The value of the cocoanut is not confined to the single export product, copra. The tree and its products are devoted to many uses. The wood in the green state is very porous and spongy, having consequently a great degree of resistance to rifle shot. In the native wars in the past it was much employed in the building of defensive works.

When thoroughly seasoned it lasts for a long time under ground, and is valuable for all purposes for which posts are employed. The oil enters in many forms into the domestic uses of the natives. It forms the basis of all their liniments and emollients in their pharmacopœia. The nut is one of the standard articles of diet. Breadfruit, taro, bananas, and cocoanuts form the staple articles of food, ranking in importance in the order mentioned. The fiber furnishes all the sennet, or braided twine and rope, for all uses. The leaves of the great branches, which dry rapidly, are used for kindling, for torches, and light and firing for the household. It is generally estimated that an acre of land should yield, when the trees have reached the period of full bearing, about half a ton of commercial copra. Copra "making" is at best a slow and laborious process, and is effected as the nuts ripen, from about the middle of April till the middle of October or early part of November—that is, during the dry season, but the making is more active in July, August, and September.

A boy or man, with a piece of sennet about eighteen inches in length, looped on either foot, will climb the slender, swaying tree with as much ease and rapidity as if it were a ladder. The notches or corrugated surface of the bark catches the bit of sennet between the feet, while the weight of the body, pressing downward, clamps as it were the hollow of the feet firmly on either side of the trunk. By this means the tree is ascended by a series of jumps. The climber with a big knife cuts away the matured nuts, which cluster close about the butts of the branches. As they fall they are gathered into piles about the base of the trees. On the plantations they are gathered into baskets slung on donkeys, or swung on poles borne by two men, to be finally piled into great heaps near the copra shed.

The nuts are not husked, the thick outer husk having become hard and brown, like wood. They are dextrously split in two by an ax, and the hard, white flesh is cut out with a large knife. Nothing remains but to spread it on mats or boards in the sun. When cured it is thrown into a heap in the shed, where it remains until placed in sacks to be carried out to a small boat, which in turn transfers it to the small schooner or cutter lying in deep water, and from this in turn it is again taken to be stored elsewhere, or transferred to the deep sea vessel for its final voyage. Copra yields perhaps a greater percentage of oil than any other of the great oil-producing staples under the modern process, whereby it is mixed with water, heated, and subjected to two pressings, giving as high as sixty-two and sixty-four per cent. of pure oil. The cocoanut crop of 1894 was by far the largest ever known in the islands, and the extent of the increase is illustrated by the fact that while the export of copra in 1891 amounted to 4,842 tons, in 1892 to 4,871 tons, and in 1893 to 4,602 tons, it rose in 1894 to 6,214 tons—an increase of 1,612 tons over the year before—an increase of about 33 per cent. over the years 1891 and 1892. In the trading stations in Samoa enormous profits are made in the copra trade. —Journal of the Society of Arts.

The modifying of the temperature of rooms has become an art, but it probably has never taken a more ornamental form than that devised by M. Pierre Roche, a French sculptor and engineer. M. Roche, taking a hint from the facts that pipes carrying liquefied gases become coated with frost, has constructed hollow metal forms of animals, etc., which are chilled by the expansion in their interior of gases liquefied under pressure. A coat of snow, hoar frost, gathers on their exterior, even in warm rooms, and the snowy figure gives a coolness to the heated atmosphere of balls and feasts.

SELECTED FORMULÆ.

Witch Hazel Liniment.—Distilled extract of witch hazel is often used either alone or in combination as a lotion or embrocation, and sometimes the tincture or fluid extract is combined directly with other liniments. Here are some formulas:

(1)	Spirit of ammonia	5 parts.
	Camphor	2 "
	Tincture of capsicum	5 "
	Alcohol	34 "
	Distilled extract witch hazel	10 "
(2)	Fluid extract witch hazel	2 ounces.
	Soap liniment, U. S. P.	14 "
(3)	Fluid extract witch hazel	1 "
	Laudanum	1 "
	Liniment belladonna	3 "
	Dilute alcohol	3 "

The preparations made from the first two formulas may be used for internal administration in doses (diluted) of ten to thirty minims.—Pharmaceutical Era.

To Distinguish Benzole and Benzine.—Owing to frequent errors made through confusion of the terms benzene (benzole) and benzine (petroleum), Prof. Lanier (Photog. Corresp.) offers several tests which are readily applicable by photographers, chemists and pharmacists who have frequent occasion to use these solvents. Coal tar benzole is colored carmine red on addition of a crystal of iodine, while petroleum benzine is colored violet; this test is very reliable, and is even applicable in admixtures of the two. To 2 c. c. of the benzole or benzine, 3 to 4 drops of a clear, ethereal solution of sandarac (1:10) are added; a permanent turbidity is imparted to benzine, while benzole, which is at first turbid, soon clears up. The addition of more sandarac solution causes the latter to become turbid. On shaking benzole with traces of alcohol it becomes turbid, while benzine remains clear.—Pharmaceutical Era.

Glass Cements.—1. Best gelatine, 100 p., dissolved by warming in 150 p. of 96 per cent. acetic acid, then add 5 p. of ammonium bichromate in fine powder. Keep away from light. When drying mended parts, expose directly to the sun.

2. Finely pulverized caustic lime 10 p., triturate with 25 gms. of fresh egg albumen, add 10 p. of water, then mix with 55 p. of plaster of Paris and apply at once.

3. Fresh casein, 100 p.; triturate well with sufficient soluble glass to make a mass of the consistency of honey. (This is more adapted to porcelain.)

4. Take ½ ounce white glue, and dissolve in the smallest quantity of water possible, then add 2 ounces proof spirits and dissolve in it 10 grains gum ammoniac and 30 grains of gum mastic. Mix carefully with the glue solution, and when wanted for use immerse in hot water until in a liquid condition. Apply to the edges of the broken material and unite carefully. This will bear an ordinary degree of warmth, but not likely to stand boiling water. Very fine white glue or Russian isinglass dissolved in strong acetic acid also makes a good cement for glass.—Virgil Coblentz, Ph.D., in Practical Druggist.

Blackening Brass.—Fleck recommends in the Photographisches Chronik the following new method of blackening brass. Clean the brass well and dip into a mixture of:

Water	100 parts.
Ferric chloride solution (40° B.)	50 "
Yellow prussiate of potash	5 "

Then wash in water and heat and rub over with linseed oil and polish with a soft cloth.

Electric Pole Indicating Paper.—Dissolve 1 to 2 grammes of phenol-phthalein in 10 cubic centimeters of alcohol of 90 per cent.; add 110 cubic centimeters of distilled water, and impregnating porous paper (blotting paper) with the milky solution. While the paper is still moist, draw it through a solution of 20 grammes of sodium sulphate in 100 cubic centimeters of distilled water. Dry at moderate heat and cut paper into narrow strips. For use, moisten the paper, and place ends of wires on it at a distance of about ¼ inch to ⅛ inch. A red spot or strip will then appear at once at the negative pole.—Prometheus.

Chromium Glue.—Glue, when combined with chromates and exposed to light, loses its solubility in water, and can, therefore, be used as a cement for articles exposed to moisture. The following is a suitable formula:

White glue	5 to 20 parts.
Water	20 "
Potass. bichromate	1 to 2 "
Water	10 "

Make solutions of the glue and potassium bichromate in separate portions of water, as indicated above (the glue being dissolved by heat); stir in the solution of bichromate; mix well, and then pour the mixture into tin boxes and allow it to congeal therein. For use, take a sufficient quantity of the glue, melt it in a cup standing in boiling water; place a layer uniformly on the fractured surface, press them together and expose the articles to the sun for a few hours.

A magnesium light for photographic purposes is described in the British Journal of Photography as a safe and efficient substitute for magnesium wire or ribbon, which is known to be more or less unreliable. The new method of burning the metal is said to offer a perfectly satisfactory "actinic combustion." The method of preparing the medium is described as follows: It consists in the "sandwiching" of magnesium powder between sheets of paper impregnated with potassium chlorate. Magnesium powder is placed between two sheets of paper, which have been pasted over with starch. The whole, when dry, forms one single sheet. Next, each side is covered with a piece of paper impregnated with potassium chlorate, and the whole covered with a further sheet of paper pasted on each side, a thick sheet, almost like cardboard, being thus produced. It may then, when perfectly dry, be cut into lengths and ignited as required. According to the Journal of Chemical Industry, the combination is quite safe and keeps well, but anything in which potassium chlorate is used should be used with caution, as flash light accidents have been numerous and serious, and only last week a man in New Jersey was experimenting with a chlorate magnesium powder and he was killed in an explosion.

ENGINEERING NOTES.

Engineering, London, pays a handsome tribute to machine tools made in the United States, saying, "It is not a reassuring thing for those who would see the engineering supremacy of this country maintained to notice how certain American firms have ranged ahead of us in the production of a light class of machine tools, of which bicycle making machines afford an example."

The old atmospheric railway on which cars are propelled by a piston traveling in a tube placed between the rails has been revived at Baltimore, and a company known as the Atmospheric Railway and Power Company is said to have built an experimental track 50 ft. in length at Spedden's Marine Railway in that city. It is surprising how this old idea is again and again brought forward.

The Russian railway mileage, at the beginning of 1897, amounted to 26,946 miles. In 1896, 1,425 miles of new railways were put into operation and 1,390 miles were completed but not yet operated, making 3,615 miles of new construction for the year. There are also 5,535 miles of railway in course of construction by the state and private companies, and many new lines have been authorized.

According to the Hungarian Statistical Year Book, there were 8,650 miles of railroad in Hungary in 1895, against only 1,340 miles in 1866. The income from the roads was $51,800,000 in 1894, against $39,270,000 in 1888. In 1894 the total number of passengers carried was 49,578,000, against 18,990,000 in 1889. The freight transported in 1894 amounted to 40,758,000 tons, or 5,072 tons per mile, against 23,970,000 tons, and 3,600 tons per mile, in 1889.

A unique feature of the Simplon tunnel (Switzerland) will be its construction in two parallel single track tunnels spaced about 50 yards. Only one of them is to be completed at first, and if the increase of the traffic requires it, the parallel tunnel will be completed also. The new method will permit of a very easy ventilation, and will, moreover, afford two ways of access to every point of the tunnel, as the two branches will be connected by cross tunnels at intervals.—Der Stein der Weisen.

Boston's new self-propelled fire engine, which was recently described in the SCIENTIFIC AMERICAN, has been tested for its water delivery. Six tests were made, under the following conditions: Through one 200 ft. line of 3 in. hose with a 1⅛ in. pipe; through two 200 ft. lines of 3 in. hose with a 1¼ in. pipe; these two lines siamesed into a 1⅝ in. pipe; then through a 1¾ in. pipe; then through a 2 in. pipe; through one 50 ft. line of 3½ in. hose with a 2 in. pipe. The steam pressure averaged 125 pounds. All of these tests were very satisfactory. The firemen estimated that the siamesed streams would be efficacious from the street to a height of eight stories of a building. A register used to determine the amount of water pumped showed a maximum of 1,550 gallons per minute. This was accomplished at a speed of 443 revolutions, and is 200 gallons in excess of the contract requirements of the engine. The maximum capacity of the largest land engines at present used in the department is 961 gallons a minute.

The deleterious action of calcareous water on iron pipes is well known, says the Engineering and Mining Journal. The waters of the Moselle, which are only slightly calcareous, act energetically on iron, sometimes piercing the iron pipes or reservoirs to which they have access. A moderate addition of lime to the water causes deposition of a protecting crust of calcium carbonate on the iron surfaces. The iron is dissolved as ferrous carbonate, which decomposes in contact with air, forming ferric oxide and carbonic acid, which latter continues the attack. Thus a very small proportion of carbonic acid dissolved in water is capable of great mischief. The action on iron of very dilute solutions of calcium chloride, sodium chloride, potassium sulphate and calcium nitrate, with and without carbonic acid, as compared with pure water, has been studied by M. P. Petit, who gave the results of his investigation in Comptes Rendus. In the absence of CO_2, minute traces of iron were dissolved, though some was oxidized, sodium chloride and potassium sulphate acting most strongly. In the presence of CO_2, iron was in each case dissolved—most in the potassium sulphate solution, and least in that of calcium nitrate. In closed vessels, the iron oxidized was about the same with or without carbonic acid; but with access of air, the oxidation proceeded very rapidly, and especially in a solution of calcium chloride.

The British consul at Rouen, in his last report, describes a novel engineering work just commenced there. It is the first of its kind in France, and the only one like it in Europe is across the Nièvron, below Bilbao. It is called a "pont transbordeur," and serves all the purposes of a bridge, while not interfering with the free passage of ships, even of those with masts 150 ft. high. Two diminutive Eiffel towers are to be erected, one on each bank of the Seine, three-quarters of a mile below the lowest existing bridge at Rouen, and a narrow iron bridge will be suspended by chain cables between their heads. It is to be not less than 160 ft. from the level of the quays, but it is not intended either for carriages or for foot passengers. Several lines of rail are to be carried along it, and on these a skeleton carriage or platform on wheels will run. This will be dragged from side to side of the river by steel ropes passing over a driving wheel, to be worked by steam or electricity from one of the banks. To the skeleton platform will be hung, by steel hawsers, at the level of the quays, or 160 ft. below the bridge, the transbordeur, a slung carriage, within which passengers and vehicles will be transported from one bank to the other. This carriage is to be 13 meters in width by 10 in length. The electric tramways running on the quays on both sides of the river are to make a connection at this point, and the transbordeur will be fitted to carry the tramcars, so that passengers by them will cross the river without changing their seats. Unlike most such works in France, it has been left to private enterprise. The municipality grant the concessionaire a monopoly for 80 years of the bridge traffic over the Seine at this point according to a very moderate prearranged tariff. The bridge has already been commenced, and 18 months is the maximum time allowed for completion.

ELECTRICAL NOTES.

A new system of an overhead conductor for street railways is described in Le Génie Civil. The contact rail is on the roof of the cars, the contact pieces are fixed on poles. As the rails, which must touch two contact pieces at least, consequently must be very long, the system is useful only if several street railway cars are connected, else it would be necessary to place the poles too near one another.

The Pittsburg, Bessemer and Lake Erie is understood to be arranging to shift cars at the Pittsburg end of the line by means of electricity, says the Electrical Engineer. According to the reports they are preparing plans for great yards along the Union Railway. Realizing the necessity for the most economical measures in order to enable them to handle ore and other freight at the minimum of expense, they will erect a large power plant and use electric motors to move the cars. It is said that a great part of the expense incurred in handling freight destined for the mills and furnaces is occasioned by the necessity for using steam locomotives.

The London, Brighton & South Coast Railway Company has running at the present time forty-two electrically lighted trains, and the fact that future new "block" trains are to be similarly lighted is strong evidence that the system is at least successful in operation. The dynamo is placed on the baggage car, and is driven by means of a belt over the axle of the car, an automatic switch connecting and disconnecting the dynamo at the proper speeds. The accumulators are said to last nearly three years, a cleaning being necessary once every sixteen months, says the Electrical World. The average annual maintenance cost per train of ten or twelve coaches is given at $270.

Judge Bundy, an Indiana jurist, ruled a few days ago that he would admit a telephonic talk in evidence, says the Electrical Engineer. He admitted that he could find no authorities in the books, but was quite willing himself to establish a precedent. A somewhat similar question came up in Boston recently, when it was sought to prove that previous to the terrible gas explosion in the subway, the gas company had been called up and notified from the scene of the trouble. The gas manager said it was not so, but a little blue strip was produced, showing time, places and names of caller and callee. That settled it. It would be an easy thing with the aid of a device like the calculagraph to verify with fair approximation all conversational episodes about which it was desirable that no doubt or question should arise later. Even the body or topic of the conversation could be noted down with little trouble.

At the time of the preparation for handling the immense traffic which was expected at the World's Fair in Chicago the Illinois Central Railroad officials seriously considered the question of using electric instead of steam traction for this special traffic. Investigation revealed, however, that the experiments which had been conducted in electric traction up to that time furnished no satisfactory evidence of the reliability of electric traction, and its adoption was deferred. It is now stated authoritatively that the reports which were made by the chief engineer and the superintendent of motive power in 1892 have been taken up again, and last fall a committee was appointed consisting of the two officers referred to and the general superintendent, the report to be made upon the practicability of using electric traction upon the company's suburban passenger trains. This committee reported March 12, and their recommendation was so favorable to electric traction that at a meeting of the directors on March 25 the substitution of electric power for steam on the local suburban trains was approved and authorized, and the president was directed to take the necessary steps to carry out the order of the board. This does not mean that electric traction will be applied at once on the entire suburban lines, but the matter will be gone into in an experimental way and it is likely that one or more tracks will be equipped between Sixty-third Street and Chicago, or possibly from some point farther south than this. It has not yet been decided what system to use, whether the third rail or the overhead trolley, and it is not at all unlikely that both systems will be investigated practically. Great interest will center in this change and the results will be looked for eagerly by the officers of many roads who are concerned in the operation of frequent, rapid trains.

A short article by Dreisbach appeared in the Elek. Zeit., says the Electrical World, giving tables and formulas for calculating the sag under various conditions, and deducing therefrom some interesting conclusions. Bronze has a greater heat expansion coefficient than iron, and therefore the usual calculation leads to the result that the sag for bronze wire increases more rapidly than that for iron, for increasing temperatures: the results for higher temperatures determined in the usual way are inaccurate, as in the calculation of the change in length of the stretched wire the elasticity is not considered; by omitting the change of length due to elasticity one obtains for the length and the sag too high values for the higher temperatures; the error, furthermore, is different for iron and for bronze wire; as it is becoming more general to use bronze and iron wires on the same poles, a more accurate investigation of the subject is important; this he then proceeds to make. His results are given in formulas and tables. He says, among other things, that if the sag of two wires of different materials is to be the same for the same temperature, the wires for this temperature should have a tension in proportion to their specific gravities in the case of iron and bronze in the ratio of 782 to 891. The results are also given in the form of curves, showing the difference between the correct and the other method of calculation. From these he draws the following conclusions: For large distances between poles the sag increases nearly in proportion to the temperature; when the change of length due to the elasticity is not considered, this proportionality does not exist, the differences for the usual mean and higher temperatures being quite considerable; the curves for the tension are similar; for the same distance between the poles the curves for the sag of iron and bronze wires are nearly parallel, from which it follows that no fear need exist concerning the advisability of suspending iron and bronze wires from the same poles. His results are only approximate.

MISCELLANEOUS NOTES.

It is said that aluminum cannot be engraved upon in its ordinary condition, as the tool will not take hold. A mixture of rum and olive oil in equal parts, however, remedies the difficulty.

A block of granite weighing over 1,000 tons was dislodged and moved 6 inches from its natural bed by a blast of only 40 pounds of powder at the quarries of the Chapman Slate Company, near Bethlehem, Pa., on March 30. The block measured 67 ft. long, 14 ft. deep and 13½ ft. wide.

Recently a block of granite weighing 1,217 tons was used as the pedestal of the equestrian statue of Peter the Great at St. Petersburg, having been transported four miles by land over a railway and thirteen miles in a caisson by water. The railway consisted of two lines of timber furnished with hard metal grooves, between which grooves were placed spheres of hard brass about 6 in. in diameter. On these spheres the frame with its load was easily moved by 60 men, working at the capstans with treble purchase blocks. Another large block, measuring 35×16×14 ft., was a few months since taken out at the Craigneth quarries, near Dalbeattie, Scotland, says the National Builder. Its weight was estimated at 650 tons.

A novel method of increasing the use of spirits in the arts has been devised by the Verein des Spiritusfabricanten in Germany, which has lately deposited with the state finance department a sum of money to be devoted to the testing of spirit motors. A number of engineers have been deputed to test any alcohol motors brought under their notice. The tests are to be carried out at the works of the engine builder, but at the cost of the syndicate. The question of whether alcohol can be used in place of petroleum in small motors for motor carriages and general use is also attracting attention in France, but, according to the most recent tests, alcohol can never compete with petroleum spirits, on account of its greater cost. It has been found that a franc's worth of petroleum spirits will give 15 horse power hours as compared with only 8 horse power hours for the same cost of alcohol.

Bamboo and bamboo wares constitute an important item in the miscellaneous export commerce of Japan. Bamboo for shipment abroad is grown in districts adjoining Kyoto and Osaka, and in Shikoku, and in Kyushiu, the varieties differing somewhat, according to localities. In Hiroshima the black and the spotted varieties grow; the former is produced in Kochi, also in many parts of Kyushiu. Bamboo grown in Yamaguchi, Oita, and Ehime belongs to the cheap varieties. The cultivation of black bamboo is carried on extensively in Kochi, where a tan—a quarter of an acre—of bamboo yields thirty to sixty yen per year. Bamboo is exported to most countries of Europe, and also to America and Australia. The bulk of the bamboo shipped from Kobe—from which place nine-tenths of the total are exported—goes to England, the varieties being black, spotted, and white.

The Annales de Géographie for March contains a statistical paper on Italian emigration in which it is stated that there are now more than two million Italians in foreign lands. Brazil had, in 1892, a little over, the Argentine Republic a little under half a million, and France and the United States had each about three hundred thousand. The province of Venice contributes the greatest number and Rome the least, while the number of permanent emigrants is considerably greater than those who only temporarily leave their homes. The present annual emigration is very nearly equal to the excess of births over deaths. This paper is followed by an account of the geographical results of the Toutée expedition from Dahomey to the middle Niger, and a description of the oases of Touat and their approaches from southern Algeria, apropos of recent military operations in this region. The latter article is accompanied by a map and several illustrations.

Some interesting data relating to the estimated comparative local cost of different pavements in respect of first cost, maintenance, scavenging and watering over a period of thirty years have been furnished in a report by the borough engineer of Wolverhampton, England. Granite sets on a bed of Portland cement concrete 6 in. thick cost $3 per square yard and have a probable life of 30 years. Australian hard wood blocks on a bed of cement concrete 6 in. thick cost $4.50 per square yard and have a probable life of eighteen years, while creosote deal blocks similarly laid require the expenditure of only $3 per square yard, with a correspondingly diminished life of 12 years. Natural rock asphalt pavement 2 in. in thickness, on a bed of Portland cement concrete 6 in. thick, can be laid for $3.35 per square yard, the life being calculated at 15 years. The total cost of each of the above mentioned pavements during 30 years for maintenance, scavenging and watering is fixed as follows: Granite sets for an area of 7,992 sq. yds., $45,000; Australian hard wood, same area, $87,210; creosote deal, $73,800; and natural rock asphalt, $65,175.

A giant seesaw is being built, says Engineering News, as one of the amusement features of the Tennessee Centennial Exposition, to be held at Nashville, Tenn., from May 1 to Nov. 1, 1897. This seesaw will be supported by a steel central tower, 30 ft. square at the base and 75 ft. high to the upper pin. On this pin will be swung vertically a built steel beam, rectangular in section, thoroughly braced and 160 ft. long. From the meager plans presented, it would appear that this beam will be swung on its axis by means of two segments with which pinions driven by the operating machine engage. To the ends of the beam are suspended two cars capable of holding 25 persons each, and these cars can be lifted alternately to a point 150 ft. above the ground. Contracts have been let for the work to the following firms: The Shultz Brady Company, of Pittsburg, the steel construction; the Central Iron Works, of Michigan, the machinery; and the Triangle Electric Company, Cincinnati, the special motor to run all the machinery. All work was to be finished May 1, and the company building the seesaw is organized with a capital of $25,000. A somewhat similar device was proposed for the Chicago Exposition, but it was rejected for the Ferris wheel.

THE EAST FRONTIER OF DAHOMEY.

THE theoretical boundary line of the east frontier of Dahomey was decided upon by an arrangement signed at Paris on August 10, 1889, by delegates of the English and French governments. It comprised three sections: 1. From the coast to the lagoon of Porto Novo, in following the meridian passing through the mouth of Adjarra River; 2, along the course of the Adjarra, from its mouth to the point called Adjarra Creek; and 3, along the meridian passing through Adjarra Creek, and longitude 0° 26' 41" east of Paris, and from this point as far as to the ninth parallel. The arrangement stipulated, besides, that the practical determination of the frontier upon the ground should devolve upon mixed commissions appointed to this effect by common agreement.

As long ago as the month of May, 1890, the first mixed commission, composed of Lieutenant Tracon and Officer MacKinstry of the British navy, determined the first two sections. Although it was applicable only to an extent of frontier of about twelve miles, this work, through an absolutely marshy zone, presented great difficulties. The manner in which these were surmounted does the greatest credit to the boundary settlers of 1890.

It remained to fix the boundary of the largest portion of the frontier, from Adjarra Creek, near the English village of Dopetou, to the ninth parallel—about 180 miles.

Such was the role of the mixed commission of 1896. This commission consisted of five members: Messrs. Fuller, Fowler, and Hay, on the part of England, and Capt. J. Ple and Ensign Brisson, on the part of France.

The commission took with it forty men as an escort, about forty hammock men and three hundred and fifty carriers. This was a large force when we consider that it was not a question here of reaching a definite point in selecting a line of operations marked out by villages, large or small, that could be relied upon to furnish subsistence for each day, but that it was necessary, by the very object of the commission, to deviate as little as possible from an imaginary line, the meridian, whose vicinity might be wholly devoid of resources.

At the beginning of the operations, in fact, one had only a very imperfect idea of the nature of the zone to be traversed, and there existed no bona fide topographical document capable of serving as a certain guide. From Dopetou, which had been fixed in 1890, the commission proceeded north in endeavoring to ride along the meridian that was to serve as a base for the common work. The zone that it at once entered was full of beauty. It was an equatorial forest with rich species of trees, vigorous palms and delightful shade. Innumerable charms and superb footpaths everywhere attested the vicinity of important centers and interrupted commerce.

DANCE OF STILTSMEN AT MEKO, DAHOMEY.

Thus the march proceeded as far as to Igangha, that is to say, for a distance of nearly thirty-six miles. Among all the inhabited centers met with, it is impossible to pass over Igangha in silence. By the number of its inhabitants, the abundance of its products, its markets and the reviving influence of its fetich king, who was formerly powerful, it is a valuable foothold for us upon our east frontier.

Starting from this place, the foothpaths become rare and the villages met with are merely a succession of ruins, although the vegetation remains always superb.

Such are Ohoumbe, Hayan, Issalé, Tobolo, etc. This is one of the fields of exploits of the warriors of Behanzin. When the King of Abomey needed slaves, either for human sacrifices or for the exchanges that permitted him to procure arms, he immediately invaded the countries in the vicinity of his kingdom. Each had its turn. The one under consideration had its more than once, and terror always reigned there.

It is to such terror that must in great part be attributed the manifestation of gratitude of which the natives are so prodigal. In us they salute their liberators, undoubtedly, but those that they salute especi-

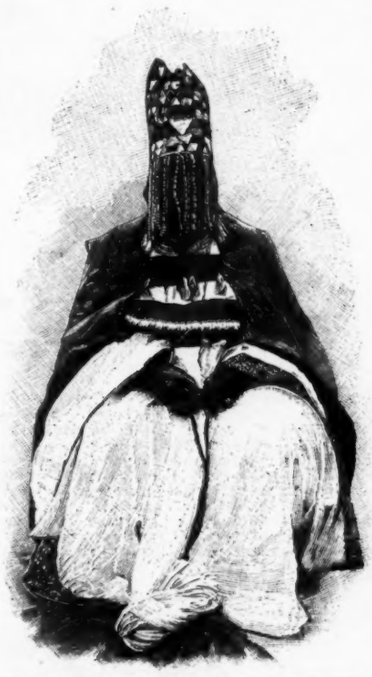
SERGEANT HAOUSSA, COMMANDER OF THE ENGLISH ESCORT.

ally are the conquerors of Behanzin, the invincible. The following is one example out of hundreds. At Issalé, Captain Ple, after receiving the chief surrounded by his suite, had the feticher of the place called and offered him a cooling beverage; but the chief ordered him, before drinking it, to say a few words of welcome to the whites. The minister of worship immediately began an harangue in which he pictured the misfortunes of the people in the past and ascribed their relief from the burdens that they were formerly obliged to bear to the advent of the tricolored flag. The same feeling was expressed everywhere.

The destitution of these men and their fatigued and sickly appearance was really pitiable. The resources of the region are very meager and scarcely suffice to feed the people. So it was necessary for the expedition to hasten to reach important centers, even if they had to lose sight for the moment of its principal objective. It was thus that it reached Ketou. This town, before paying its tribute to the Dahomian invasion, was the center of a large population, say of about 30,000 inhabitants. Its ramparts were solid and capable of defying terrible assaults. In 1878, the Dahomians took it by famine. The new town, built alongside of the ruins of the old one, consists of common huts, and contains about 3,000 inhabitants.

The commission, upon its arrival, found an enthusiastic population, which by songs and interminable dances did its best to show its joy at receiving it. The king caused himself to be announced. Noisy tomtoms and rhythmed songs signalized the march of the procession that led him to the field. Three children armed with whips, and who acted as pages, preceded him, pushing out of the road that he was to follow all those who did not bestir themselves quickly enough. Upon coming within about three hundred feet of the European tents, he stopped and sat down.

The chiefs of the different quarters of the town, wearing a long white shirt and carrying a long ebony staff



THE KING OF SAVE IN HIS FETICH COSTUME.

as insignia, immediately came to prostrate themselves before him.

Finally, the king was received by the chief of the commission, and, as for conversation, confined himself to a repetition of the phrases that were spoken to him in a loud voice by the intelligent fellow who acted as his prime minister.

From Ketou, the commission started for Meko, a center composed in great part of Mussulmans, who are French at heart, but whom the boundary line has given to the English colony at Lagos.

Here the reception given to the French flag was more enthusiastic than anywhere else. Dances and songs succeeded each other uninterruptedly, as at Ketou, but all this assumed here a phase of remarkable originality. Thus in the afternoon of the day of its arrival, the commission suddenly saw an immense crowd advancing toward the field in dancing, singing and turning in groups around individuals perched upon stilts. It was a fetich dance.

The dancers, with veiled face and dressed in costumes made of coarse fabric and straw like that used for making the mats of the country, rushed to one side and the other and made believe charge upon the crowd, which, at every step, gave way in singing, gesticulating and continuously provoking the fetich stiltsmen.

After leaving Meko, the meridian was followed for nearly thirty-six miles through an absolutely desolate region in which neither water nor food was found, but at the end of which, Oepara River, near Djabata, offered an unlooked for compensation.

Passing through a remarkable series of granitic uplifts, the commission reached Savé. This place, which formerly depended upon Ketou, has now acquired considerable influence that is tending to increase from day to-day. Its king is not, like that of Ketou, a perfect nonentity, but is a man of action and of physical and intellectual capacity. What he desires before all else is the development of such commercial transactions as are capable of being effected in the regions that recognize his authority. In order to bring this about, he is leaving the field free to all initiatives and all religions.

Upon the right jamb of the main door of his palace there is carved a small fetich, and upon the left one there is reproduced a page of the Koran.

The king sometimes wears a fetich crown, and sometimes dresses in the Mussulman costume.

PAGES OF THE KING OF KETOU.

The region to the north of Savé is populous, fertile and interesting. The influence of the King of Savé extends as far as to Tchaouron.

The commission afterward visited the Baribas, and after passing a few days in their country began its return voyage, not by the same road, but in following the windings of Oepara River, which Captain Ple desires to propose as the natural frontier, instead of the imaginary meridian.

The frontier admitted at present by the two governments will very probably be divided into two very distinct sections—both materialized upon the ground: 1. From the village of Dopetou to the meeting of the river Oepara, near Djabata, it will follow either the valleys of small watercourses having a north-south direction, or a line parallel with the different footpaths having the same direction. 2. From the meeting of the river Oepara, the frontier will follow the valley of the latter as far as to the ninth parallel.—L'Illustration.

According to Engineering News, Japan came to Philadelphia to buy a chimney for the electric lighting plant at Yokohama. It is a steel shaft 175 feet high, 7 feet in diameter and weighs over 90,000 pounds.

THE ANGLO-FRENCH BOUNDARY COMMISSION AT DOPETOU.

DINOSAURS.*

IT is only sixty years ago since George Catlin wrote his "North American Indians," and graphically described the vast herds of bison, numbering millions of individuals, traveling for days together across the rolling prairies; yet we have seen these disappear, like the aborigines, and their places usurped by the "cowboy," and by countless herds of domestic cattle.

If we could only wind the clock of time still further backward, and make him disclose, with moving photographic vividness, some of those earlier Mesozoic scenes on the American continent, or even in our own little island, for that matter, we should find, not herds of bison, but far other cattle, though some wore horns, and were big and ugly enough in all conscience; yet they were mostly harmless, and herbivorous in diet,

FIG. 1.—Restoration of Anchisaurus colurus, Marsh ($\frac{1}{10}$ nat. size). Triassic, Connecticut. The reptile which is believed to have made the birdlike bipedal footprints upon the Connecticut sandstones.

belonging to patterns now entirely obsolete, like the old "brown bess" of our grandfathers' days, only more so.

And, doubtless, it is due to the extreme rarity of preservation of old land surfaces, as compared with the far more numerous and abundant records of marine areas which have come down to us, that renders their discovery of such paramount interest to the biologist and geologist. The vast physical changes also which they indicate are, undoubtedly, owing to the immense and unmeasured periods which have intervened, filled only by the slow music of the sea.

Thus, after parting company with Eocene mammals, such as Tinoceras, we take a plunge in the sea of time, and come again on shore to find that all but the tiniest of mammals are absent, and the land is peopled by huge herbivorous and somewhat lesser carnivorous dinosaurs in their stead.

Although this strange reptilian order was discovered so early in this century, it is only within the last thirty years that, thanks to Prof. Huxley, we have been led to understand them; and not till 1881 had we a correct notion even of the skeleton of our own famous Iguanodon, though Mantell had commenced to record the discovery of its bones in Sussex in 1825.

One of the most curious points about these mediæval animals is that they make their earliest appearance in the Triassic period, and were first known in North America some sixty years ago, not by their bones or teeth, but by their footprints. These tracks, discovered so abundantly on the fine grained, often fissile, sandstones of the Connecticut Valley area, were at first attributed to birds, although any birds earlier than the Tertiary period were then unknown.

Yet the genius of Huxley had demonstrated (in 1868) that in the Dinosauria we are dealing with a group of reptiles which most nearly approached the flightless birds, not merely in the weakness and smallness of their fore limbs, but in the structure of the pelvis, the ilium prolonged forward in front of the acetabulum as well as behind it, and the long rodlike ischium and pubis being all strongly ornithic characters; the head of the femur being set on at right angles to the shaft of the bone, so that the axis must have been paralliel

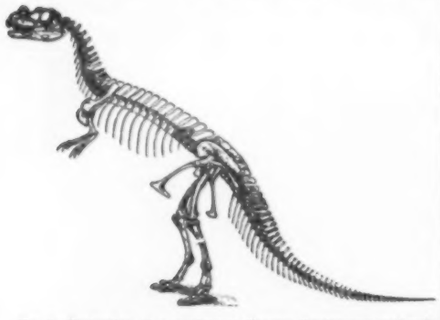


FIG. 2.—Restoration of a carnivorous dinosaur, Ceratosaurus nasicornis, Marsh ($\frac{1}{20}$ nat. size). Jurassic, Colorado.

with the median vertical plane of the body, as in birds. The metatarsals were free as in young birds, not anchylosed together as in the adult ones; moreover, in Iguanodon and some other forms met with, the number of functional digits was three, as seen in the foot of Dinornis, and in the great majority of living birds, and the number of the phalanges agrees with that in the II, III and IV toes of the emu and rhea; or any other typical bird's foot. So that there is good reason to conclude that the Connecticut footprints, instead of being those of birds, were certainly the tracks left behind by the birdlike dinosaurs of that period.

From the great difference in size between the fore and hind limbs, Mantell and Leidy concluded that the Iguanodon, and some others of its kind, may have supported themselves for a longer or shorter period upon their hind legs. This conclusion was further confirmed by the discovery made by Mr. S. H. Beckles, F.R.S., of huge three toed footprints occurring in pairs upon ripple marked surfaces of Wealden sandstone near Hastings, of such a size, and at such a distance apart, as to lead to the conclusion that they were undoubtedly made by Iguanodon. Mr. Beckles' discovery has since been confirmed by the observations of Louis Dollo upon the Bernissart Iguanodon in the Brussels Museum, a cast of which may now be seen set up in the British Museum of Natural History, Cromwell Road.

A few detached reptilian remains from the Trias of America had been made known by Dr. Leidy and Prof. Hitchcock as early as 1854 and 1856; but in 1884, Prof. O. C. Marsh obtained for the Yale University Museum a large part of a dinosaur about 8 feet in length, and, later on, a smaller but most complete example, named by him Anchisaurus colurus, of which five individuals were discovered, all being of carnivorous type, and the oldest known of the division Theropoda. Marsh feels confident that these and other (perhaps herbivorous) forms were the makers of the bipedal tracks met with in such numbers in the Trias of America, for of the presence of birds at this period we have no evidence whatever.

Passing from the Triassic sandstones to the Jurassic period, we have in the various deposits from the Lias of Charmouth, with its herbivorous dinosaur, Scelidosaurus harrisoni, to the inferior and great Oolite, with its Megalosaurus, its Omosaurus and Cetiosaurus in this country, represented by Atlantosaurus, Ceratosaurus, Stegosaurus, Brontosaurus, Comptosaurus, Laosaurus, and many other well known forms, discovered and described by Marsh, from the Jurassic beds of Colorado and Wyoming Territory, U. S. A.

We have, in fact, in the Jurassic period, entered upon "the age of dinosaurs;" and if, as seems now to be the general conclusion arrived at concerning the age of our own Wealden formation—by Seward, from an examination of the plants; by A. Smith Woodward, from the mammals and fishes; by Marsh, from the reptiles—this deposit is also of Oolitic age, and thus another old land area must be relegated to the Jurassic, rather than to the Cretaceous epoch, and we may look upon Iguanodon as an Oolitic type.

Indeed, if the Iguanodon had not been contemporary with the Megalosaur in the Jurassic period, we should have had repeated over again the mournful story of the poor lion, in the Roman amphitheater, who hadn't any Christian to eat; for the carnivorous Megalosaur of the Oolites would, in that case, have often gone supperless to bed for want of his Iguanodon.

Admitting the strong palæontological evidence which has been brought forward (Geol. Mag., 1896, pp. 8 and 69) in favor of the Jurassic age of the Wealden beds; nevertheless the age of dinosaurs did not terminate until the close of the Cretaceous epoch, for Huxley described (Geol. Mag., 1867, p. 65) a small armed dinosaur (Acanthopholis horridus) from the Chalk-marl of Folkestone, and Seeley has determined another (Orthomerus Dolloi) from the Maestricht Chalk (Q. J. G. S., 1883, p. 248); while Marsh has obtained from the Cretaceous beds of the Laramie, in Wyoming, most complete evidence of the entire skeleton of Claosaurus annectens, one of a family of herbivorous dinosaurs, in which the cheek teeth are very numerous and arranged in vertical series, not fewer than 150 being present, while the anterior portion of the jaws are narrower and edentulous, but produced in front in a rather wider predentary bone, which was, in all probability, covered with a

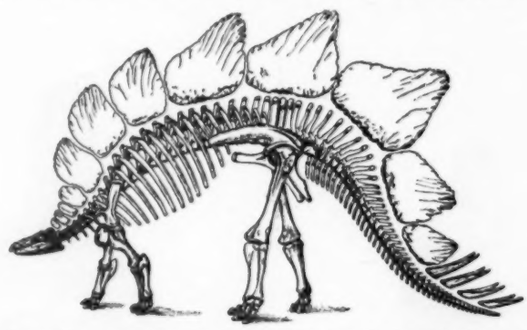


FIG. 3.—Restoration of Stegosaurus ungulatus, Marsh ($\frac{1}{10}$ nat. size), a hoofed and armored herbivorous dinosaur from the Jurassic of Wyoming. (The size of the brain of Stegosaurus was only $\frac{1}{600}$ that of a young alligator's, if the weight of the entire animal is considered.)

horny mandible fitted to meet the strong beak above. Save the more slender head, and the small and feeble fore limbs, Claosaurus greatly reminds one of Iguanodon.

In support of the erect position in which so many of Marsh's animals are represented, it may be well to mention that Claosaurus has "in the median dorsal region, between the ribs and the neural spines, numerous rodlike ossified tendons, which increase in number in the sacral region and along the base of the tail, and then gradually diminish in number and size, ending at about the thirty-fifth caudal. These ossified tendons are well shown in the restoration (Fig. 6), and are of much interest." Similar ossified tendons are

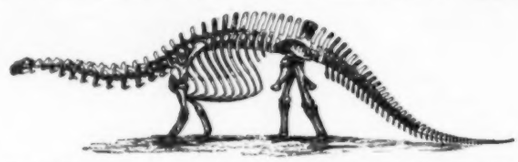


FIG. 4.—Restoration of Brontosaurus excelsus, Marsh ($\frac{1}{50}$ nat. size, length 60 feet), a huge unarmed herbivorous dinosaur from the Jurassic of Wyoming. (Estimated when living to have weighed 20 tons! A stupid, slow moving reptile, probably existing upon aquatic or other succulent vegetation.)

seen in Iguanodon, and they doubtless served to give attachment to the great dorsal muscles which supported the vertebral column when the animal assumed an upright attitude, or when it used its immense and powerful tail as an oar in swimming acrossa stream.

Another, and possibly the most singular, as well as one of the latest of Prof. Marsh's pets, is the huge Triceratops prorsus, one of the quadrupedal dinosaurs, with a skull armed with three horns, two of which were nearly a yard long, and having a bony frill, like an immense Elizabethan ruff, four feet broad, attached to the back of its occiput, the cranium and frill being 6 feet in length from the nose to the hinder border of the bony ruffle.

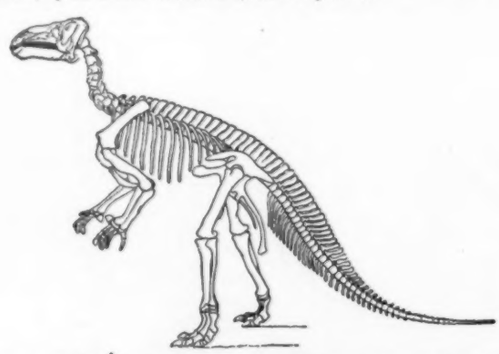


FIG. 5.—Restoration of Iguanodon Bernissartensis, Boul. ($\frac{1}{20}$ nat. size). An herbivorous dinosaur from the Wealden (Upper Jurassic?), Bernissart, Belgium.

But skulls of Triceratops horridus have been obtained by Marsh measuring from 7 to 8 feet in length.

Its horns, when found broken off from the skull, were so like the bony horn cores of some bovine ruminant as to have been suspected to belong to some very ancient ox; but certainly such three horned beasts would have been "kittle cattle" to yoke, or to plow with!

The beaklike, edentulous character of the mandibles is very striking, and from the vascular surface of the horn cores and bony frill, these too, when living, must have been sheathed in a strong horny external covering.

The teeth are very remarkable, having two distinct roots; this is true both of the upper and the lower

* "The Dinosaurs of North America." By Othniel Charles Marsh. Extract from the Sixteenth Annual Report of the United States Geological Survey, 1894-95. C. D. Walcott, director. Imperial 8vo. Pp. 133 + 414. Pl. ii + lxxxv. (Washington, 1896.)

series. The roots are placed transversely in the jaw, and there is a separate cavity more or less distinct for each of them. They form a single series only in each jaw.

The brain of Triceratops appears to have been smaller in proportion to the entire skull than in any known vertebrate.

Although we have nothing in this country which can for a moment compare, in magnitude, with the vast areas in the Western Territories of the United States, often covered to an enormous thickness by great lacustrine deposits of Tertiary, Cretaceous, Jurassic and Triassic age, full of evidences of old land conditions, yet in our limited island we can show evidence probably of ten successive land stages from the Wealden to the Trias, marked by mammals or dinosaurs, by

FIG. 6.—Restoration of Claosaurus annectens, Marsh, an herbivorous Dinosaur ($\frac{1}{40}$ nat. size). Cretaceous, Wyoming.

pterodactyles, and by insects, by plants and carbonaceous shales or coal seams; so that throughout the lower Secondary series, at least, we can lay down buoys to mark the spots where the old land was situated, though of its actual extent we know but little.

What, we may well ask, were the peculiar conditions of life in the Mesozoic period, which brought about the evolution and continuance through this long æon of such a remarkable land fauna? The associated Jurassic flora may help to solve this query. It consisted largely of Araucarias, Thujites and other Coniferæ, of Cycadeæ and palms, of tree ferns and many species of Filicinæ, of lesser growth, of giant Equisetums, of liverworts and club mosses, and some herbaceous and aquatic plants; but, so far as our records tell, no grasses had as yet made their appearance. It is, therefore, certainly reasonable to conclude that most of the herbivorous dinosaurs must have subsisted, almost wholly, by browsing upon the leaves, shoots and young branches of arboreal vegetation (as did the giant ground sloths of later Tertiary times in South America), although some may perhaps have fed upon aquatic plants.

This habit, doubtless, tended to develop their frequent bipedal mode of progression amid the tall and luxuriant vegetation along the river banks where they pastured. It also enabled them the better to espy the approach of their enemies, the light leaping Hallopus and Compsognathus, and the fierce Allosaurus and Megalosaurus. These beasts of prey assumed the erect position, not only to observe, but also to rapidly overtake and leap upon their quarry; and it may be, too, that they were able to deceive them by their superficial resemblance to the vegetarians, who were literally taken in by them.

We cannot, in so brief a notice, do justice to the labors of Prof. Marsh in this interesting field of inquiry; but those who care to take up this latest volume on dinosaurs will find it well repay the perusal. His studies of the brains of these ancient reptiles is alone deserving the most careful consideration. The camparison of the brain of Stegosaurus ungulatus with the enormously larger neural cavity in the sacrum has led to the statement that Marsh had discovered an animal with its brain in its tail! "This reminds me"—I was asking the late Capt. Speke on his return, in 1864, from Somaliland, what he thought of the Somalis, to which he replied, "They are a splendid race of men, only, unfortunately, their brain is developed at the wrong end of their backbone."

The present work by Prof. Marsh is, after all, but a summary of more than fifteen years' labor in the field and in the museum, and may, it is hoped, be followed by even a larger monograph. Nevertheless, this volume is a storehouse of facts and figures (there are eighty-four plates!), and will prove of the greatest value to the paleontologist and the biologist.—Nature.

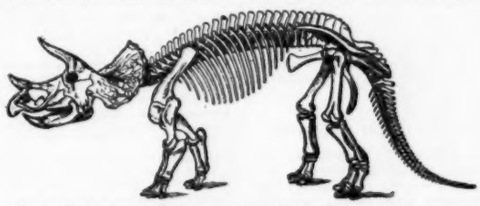


FIG. 7.—Restoration of Triceratops prorsus, Marsh ($\frac{1}{40}$ nat. size). Cretaceous, Wyoming. (Length in life about 25 feet, height 10 feet.)

PRODUCTIVE FORCES OF CUBA.*

WITH an area about equal to that of the State of Pennsylvania, a length of 775 miles, and a width varying from 30 to 160 miles, Cuba stands in a geographical position which, together with her productive soil, mineral wealth, and climatic conditions, should entitle her to rank among the foremost communities of the world, a distinction to which I believe she will soon attain whenever a stable government and cheerful obedience to the powers that be present to the home seeker and investor conditions that will make home pleasant and capital secure.

*United States Consular Reports.

Although founded and settled more than fifty years before the United States, Cuba has still 13,000,000 acres of primeval forests where the woodman's ax has never been heard. These forests are timbered, besides other woods, with mahogany, cedar, logwood, redwood, ebony, lignumvitæ and caiguaran, the latter being more durable in the ground than iron or steel.

The soil is a marvel of richness, and fertilizers of any kind are seldom used, unless in the case of tobacco, even though the same crops be grown on the same field for a hundred years, as has already happened in some of the old sugarcane fields. The mountains are of coral formation, while the lowlands of eastern Cuba, at least, seem to be composed largely of fossils of sea matter from prehistoric times, and are extremely rich in lime and phosphate, which accounts for their apparent inexhaustibleness.

If all the land suitable to the growth of sugarcane were devoted to that industry, it is estimated Cuba might supply the entire western hemisphere with sugar. The island has already produced in a single year for export 11,000,000 tons, while its capabilities have only been in the experimental stage.

The adaptability of the soil for tobacco culture has long been the envy of the world, until a cigar that has not some pretension of having at least a little Cuban tobacco stands condemned without a hearing.

Cuba takes great pride in the quality of her coffee, and until the rebellion of 1868 she raised a large quantity for export. It is the mountainous regions of Santiago, in the eastern part of the island, that are best adapted to this industry, but the insurrection beginning that year completely destroyed the coffee plantations. They were just getting nicely started again, when the present rebellion broke out, and there will probably be but a few, if any, coffee plantations remaining when the struggle ends. Coffee, unlike sugar, can be raised profitably on a small scale and is eminently the poor man's crop.

Tropical fruits, such as oranges, lemons, pineapples, mangoes, guava, tamarinds, and many fruits with a local value, but too short lived for export, are here entirely at home and never catch the unlooked for frosts, as so frequently happens in Florida. These fruits are indigenous to the soil and require but little labor to make them grow successfully.

The cereal crops never have, and probably never will have, a profitable cultivation on this island. Corn is raised on a small scale, while wheat and oats are never grown at all. No flour mill exists on the island, so far as I have been able to learn.

The lover of fresh vegetables, I think, is doomed to disappointment on coming to Cuba. Garden truck is always in season and can usually be had at some price, but that crisp freshness which we so much relish in our northern vegetables seems to be wanting, and vegetables being always in market, one soon tires of them. But, when our own ground is covered with snow and ice, they might be shipped north to some advantage.

In mineral wealth Cuba is capable of taking high rank. Gold and silver have not been found in paying quantities. Copper was mined at Cobre by the natives before Columbus discovered the island, and there is strong proof that native copper was carried across to Florida and used by the Florida Indians hundreds of years ago. The mound builders of that State buried with their dead, copper ornaments and utensils hammered from native copper, which always has an admixture of more or less foreign matter. As no copper ore is found in Florida, nor in the United States for a long distance from there, and as that found in the United States or in Mexico does not correspond chemically with that buried with the mound builders, it occurred to Prof. R. H. Sanders, of the Academy of Natural Sciences, in Philadelphia, that it was possible that these mound builders had water communication with Cuba, and got their copper from here. He therefore communicated with the writer and procured a sample of native Cuban copper, which proved, upon analysis, to be the identical kind used in the copper ornaments mentioned. In the early part of the present century, some English capitalists purchased these mines, which are nine miles from Santiago. The books of this consulate show that from 1828 to 1840 an average of from $2,000,000 to $3,000,000 worth of copper ore was shipped annually to the United States from these mines. How much was shipped elsewhere, I have not the means of knowing.

These mines continued in successful operation until 1867, when a combination of circumstances, and not the poverty of the mines, closed them up, and the various shafts, from 900 to 1,200 feet deep, filled with water, all save 300 feet being below the level of the sea. In later years, considerable copper was taken from these mines by pumping the water from the shafts to tanks, into which iron scraps were thrown. The copper held in solution by the water deposited on the scrap iron, which in time was broken off and the iron used again. It is generally believed that large quantities of copper still remain unmined in this locality.

The iron mines of Cuba, all of which are located near Santiago, overshadow in importance all other industries on the eastern end of the island, constituting the only industry that has made any pretense of standing up against the shock of the present insurrection. The Juragua and Daiquiri iron companies (American), with a combined capital of over $5,000,000, now operate mines in this vicinity and employ from 800 to 1,400 men, shipping to the United States from 30,000 to 50,000 tons of iron ore per month, the largest portion of which is used at Bethlehem, Steelton, Sparrow's

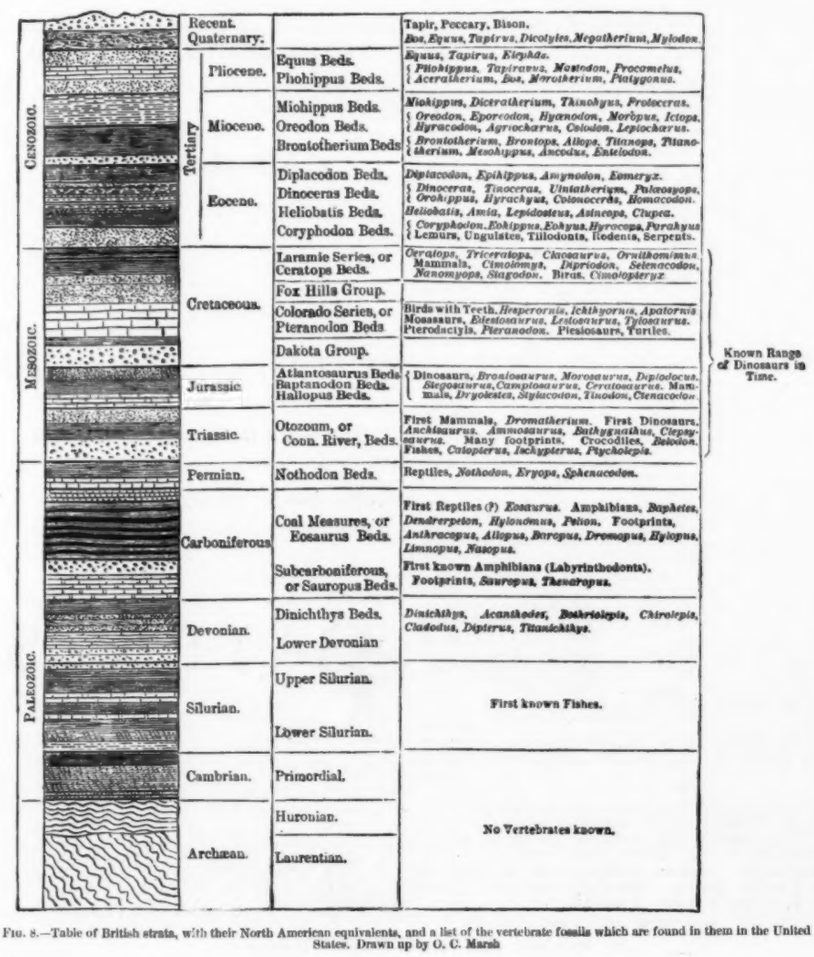


FIG. 8.—Table of British strata, with their North American equivalents, and a list of the vertebrate fossils which are found in them in the United States. Drawn up by O. C. Marsh

Point and Pittsburg. The ore of these mines is among the richest in the world, yielding from 62 to 67 per cent. of pure iron, and is very free from sulphur and phosphorus. There are numerous undeveloped mines of equal richness and value in this region.

In the Sierra Maestra range, on the southern coast of Cuba, from Santiago west to Manzanillo, within a distance of about 100 miles, are found numerous deposits of manganese, an ore indispensable in the manufacture of steel. American capital opened a mine about 20 miles distant at a place called Ponupo, and built a railroad to it. After shipping one cargo, the mines were stopped by the insurgents. As nearly all the manganese used in the United States comes from the Black Sea regions of Europe and a smaller quantity from the northern part of South America, it is but reasonable to suppose that the products of these nearby mines will be in great demand when the conditions are such that they can be operated in safety.

Railroads and other highways, improved machinery, and more modern methods of doing business are among the wants of Cuba; and with the onward march of civilization these will be doubtless hers in the near future. Cuba, like other tropical and semitropical countries, is not given to manufacturing; her people would rather sell the products of the soil and mines and buy manufactured goods. The possibilities of the island are great, while its probabilities remain an unsolved problem. PULASKI F. HYATT, Consul.

Santiago de Cuba, January 8, 1897.

BICYCLING IN GERMANY AND FRANCE.

SOME particulars of the Fahrrad-Vorschrift, or instruction concerning the training of bicyclists in the German army, are given in a recent number of the Militar Wochenblatt. The first part of the instruction is a description of the machine, which, as we learn from the Deutsche Heeres-Zeitung, is a small safety with 1¼ inch cushion tires, there being two types, one of strong build for training and the other of lighter character for use in the field. The second part of the instruction relates to the care and cleansing of the machine, and the third to training, says the Army and Navy Journal. The Wochenblatt informs us that the period of training is divided into three parts, and that the number of men under training will be in the proportion of three to each available machine. Preliminary work begins in October, so that before the winter comes on the man is at home on his machine, and his practice is kept up during the winter months by two hours' practice weekly. From March onward the second period of the training is to fit the man to have perfect control of his machine, so as to be able to gain the full use and advantage of it. He is thus taught to be competent for military cycling duties during the maneuvers. Hand in hand with this work, the third section of training—the theoretical—goes on. It relates to the building and repair of machines, the disposition of weights, the carrying of the rifle and revolver with which the military bicyclist is armed, precautions to be taken in regard to heat and cold, the police regulations of various towns, and so forth. As will be seen, the instruction is concerned with the training rather than with the employment of the bicyclist. It concludes by saying that a number of men practically trained upon the lines laid down will soon render it unnecessary to employ civilian riders, which has hitherto been done during the maneuvers.

Up to the present time in the French army cyclists have been employed chiefly to transmit orders and carry messages, but it is now proposed to form cyclist corps of combatants—a kind of mounted infantry, using bicycles instead of ponies. An experimental company of sixty men has been formed by Captain Gérard, who has invented for their use an ingenious bicycle which can fold in two, by means of a hinge on the cross bar, so that, when folded, the front wheel and hind wheel are next each other, and the machines become readily portable on the men's shoulders. The cyclist company, as at present organized, consists of four sections, twelve men each, commanded by one sergeant and two corporals, thus making up a total of forty-eight rank and file, with four sergeants and eight corporals. The folding bicycle is provided with leather braces to enable the men to carry it on their backs. The uniform is a blue jersey, a blue flannel belt, a loose cloth jacket, cut very like a pilot coat, or an open Norfolk jacket, red trousers, close-fitting from the knee, leggins, and ankle boots. The equipment consists of the regulation belt with three pouches, each containing forty rounds of ball cartridge. In the pouch carried at the back there is room provided for the pump and the usual tools. A canvas bag is also provided to hold a spare jersey. The armament consists of a Lebel rifle and bayonet. Two cycle smiths are attached to the company. They ride a coupled bicycle and carry spare nuts, tires, air chambers, files, hammers, and other articles to repair the machines. A van is attached to the company containing a portable forge, a box of ammunition, and spare wheels, together with the men's knapsacks and officers' valises. This company was tested at the last autumn maneuvers near Laon, and was used for reconnoitering, scouting, and advanced post duties. Thus when it was thought necessary to occupy, at some distance from the main body, a given strategic point, the cycle company was dispatched to take possession of it, and, thanks to the rapidity of its movements for scouting and reconnoitering duties, it is said to have been very serviceable. When the ground is impracticable, then the men fold their machines, strap them to their backs, clamber over steep, wooded hills, and then, on regaining level ground, rig up their machines and are once more on the wing.

Spring, the distinguished English metallurgist and engineer, has just shown that two well polished plates of aluminum, pressed one against the other and heated for eight hours to a temperature of 330 degrees C., do not fall apart. They act as if soldered together, without, however, being so. This is a phenomenon as yet poorly explained, but which is, nevertheless, profitable to record. Other metals, such as platinum, present the same peculiar action at the same pressure. The success of the experiment seems to depend principally on the perfect cleansing and laying bare of the metallic particles at the surface, and their complete contact at all points.—From L'Electrochimie.

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